AGRICULTURAL ECONOMICS RESEARCH UNIT

Lincoln College

PROCEEDINGS OF A NEW ZEALAND SEMINAR ON
PROJECT EVALUATION IN AGRICULTURE AND RELATED FIELDS

Edited by

R. C. JENSEN

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THE AGRICULTURAL ECONOMICS RESEARCH UNIT

The Unit was established in 1962 at Lincoln College with an annual grant from the Department of Scientific and Industrial Research. This general grant has been supplemented by grants from the Wool Research Organisation and other bodies for specific research projects.

The Unit has on hand a long-term programme of research in the fields of agricultural marketing and agricultural production, resource economics, and the relationship between agriculture and the general economy. The results of these research studies will in the future be published as Research Reports as projects are completed. In addition, technical papers, discussion papers, and reprints of papers published or delivered elsewhere will be available on request. For a list of previous publications see inside back cover.

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PROCEEDINGS OF A NEW ZEALAND SEMINAR

on

PROJECT EVALUATION IN AGRICULTURE
AND RELATED FIELDS

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Edited by
R.C. Jensen

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Editor's Note

The Committee responsible for the organisation of the Seminar expresses appreciation for the willing and capable assistance of:-

Mr W.F. Musgrave, Senior Lecturer in Agricultural Economics, at the University of New England,

Dr J.T. Ward, Professor of Economics at the University of Waikato,

Their colleagues at Lincoln College,

Officers of the Department of Agriculture.

This volume of proceedings contains papers contributed to the seminar, and in addition two concluding essays prepared at the invitation of the discussants.

R.C. Jensen
One of the functions of a university is to develop its students to a high level of professional ability. Another function is to exercise scholarship by developing or refining techniques which can contribute to a better understanding of the world we live in. A third function, one which is often overlooked, is to maintain a close liaison between the "ivory towers" of sophisticated techniques, and the practitioners who are charged with the responsibility of decisions and problem-solving in the field. This third function, as it applies to Lincoln, prompted the Seminar on Project Evaluation in Agriculture and Related Fields, the Proceedings of which form the basis of this publication.

Project evaluation has "grown up" in quite recent years. We, at Lincoln have used this technique in several research projects. A growing number of people in Government and local bodies are adopting it as a tool of economic evaluation. We have felt for some time that the academic, the research workers, and the practitioner could mutually benefit from the pooling of ideas. The success of the seminar has justified our efforts, and I would like to thank all those who contributed to this success.

The Seminar made one point crystal clear - there is a very great need for administrators to become aware of the wisdom of economic evaluation - the time for guessing in the field of investment is over. New Zealand has a well-trained core of capable men whose talents in the field of economic evaluation must not be ignored by those responsible for making administrative decisions where public expenditure is involved.

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The evaluation of projects which demand capital strikes at the heart of the economic problem — that is — the making of decisions about the allocation of scarce resources amongst competing ends. In a perfectly competitive system, the "invisible hand" of the price mechanism would ensure an "economic" allocation of the resources. In New Zealand, as in virtually all countries, many of the major decisions concerning capital allocation are made by Government and local body agencies; rational decisions cannot merely be taken for granted.

In the fields which will interest us during this seminar, for example, in large scale land development, in afforestation, large scale irrigation and drainage schemes, and in soil conservation projects, it is clear that such projects have not often been subjected to rigorous economic analysis. Alternative objectives which may have been adopted include the need to find employment for depression labour in the case of some forestry schemes or certain irrigation projects, the social need to rehabilitate servicemen in the case of large scale land development, the exigencies of local politics in the case of drainage schemes, or plain emotion in the case of some soil conservation work.

Such criteria may of course be highly valid from a welfare viewpoint, which the community may consider to be more relevant than economics. Furthermore, projects justified in the first place on the grounds of non-economic criteria may turn out to be economic. I imagine, for example that this would apply to the afforestation projects in the central North Island, during the thirties. It must certainly have applied if the then known agricultural potential of the pumice country had been incorporated in any analysis. Similarly the moral demands upon the nation to rehabilitate servicemen in occupations of their choice were very strong. But here again, had their settlement on farms been analysed during the forties it is clear that satisfactory results would have been obtained, especially if the analysis had used the prices characteristic of the fifties.

It would be difficult to apply the same argument to some projects where the motivation has been parochial, and perhaps even emotional. For example there would be some irrigation operations which would have been unlikely to survive the economist's scalpel, blunt though it may sometimes be.

When we turn to the evaluation of farm development, those of us in the farm management profession would have to concede that we have been slow to adopt the methods of appraisal which are going to be discussed at this seminar. The main reason I feel is that farmers motives can rarely be reduced to mere economics, they are much more
complex and personal. Farm Management aims at meeting these different goals. It may also be argued that the pace of technological change and the degree of income fluctuation characteristic of New Zealand farming, has not provided a persuasive background for development evaluation. Additionally we may also argue that project evaluation principles have been incorporated in some of the rules of thumb we have characteristically used. For example the establishment of the total investment cost per stock unit increase resulting from development implies a marginal cost - marginal return principle and while it lacks a discounting principle, it gives us useful answer.

Nevertheless these factors do not entirely forgive us our neglect of more comprehensive methods of appraisal of farm development, particularly in our research. After all, something like $40 million per year of state money has gone into farm development in recent years, and we have had to rely on the judgement, experience and insight of district appraisers, and field officers to allocate this money. It is a commendation of their ability that so little of this capital seems to have been seriously misallocated.

It was therefore not too soon that Professor Ward started prodding us to refine our tools at Lincoln a few years ago, and it is now not too soon to take stock of the work being done, and to evaluate fully the methods and terms we are using.

While the principal objective of the seminar is to try to unify and standardize our approach to project evaluation I do not think that we should be too ambitious. It seems to me that we should strive for a general consensus rather than for regimentation of thought. Clearly there must always be scope for individuals working on specific projects to exercise their imagination and creativity in relation to their particular problems. Problems should dictate methods, and not the reverse.

Nevertheless it has become clear to us over the last few years that there are a number of important terminological and methodological matters which we need to clear up. Also we have felt that it would be useful to bring people who have had operational experience with the evaluation of projects in which we are interested, together with others whose work might benefit by an awareness of what is being done in this field, and of what might be done.

If this seminar provides a clearer and well balanced perspective of the role and importance of project evaluation in the New Zealand agricultural economy, and at the same time we have thrashed out a general consensus on methods of analysis and terminology, we shall consider it to have been worthwhile.

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SOME BACKGROUND AND PERSPECTIVE TO
PUBLIC INVESTMENT ANALYSIS

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In this paper I hope to achieve two things. First of all I intend making some general remarks relating to the "political economy" of public investment analysis. This should provide the broad canvas upon which the details of this symposium can be executed. Secondly, I will outline the history of appraisal procedures in the United States. I will also briefly describe the position in Australia. The purpose of this second task is to place public investment analysis in some perspective. The paper will not be concerned with the mechanics of appraisal but with what I believe to be some very important attributes of the practice of public investment appraisal which should be kept very much in mind throughout this symposium.

The Political Economy of Public Investment Appraisal

Any discussion of the economic analysis of public investment should not be carried out without making allowance for the political process through which investment decisions are made. The availability of investment possibilities to a governing body raises some very interesting problems and possibilities in economic policy. This is so because the existence of the investment possibilities makes possible a flexibility in the pursuit of various policy goals which would not be present in the absence of the investment possibilities. The efficient use of resources in maximising national income should not be the sole consideration of a rational government. On the other hand, the efficient use of resources in maximizing social welfare should be the sole and binding consideration. In pursuing this goal a rational government may see public investment possibilities as providing a means of promoting efficiency of resource use; it may also see them as providing a means for achieving a desired income redistribution, regional development (that is, people redistribution), of engaging in political horse-trading, and of constructing modern pyramids which raise the income of later generations and the ego of the present one.

The possibility of such multi-faceted attitudes to public investment must introduce possibilities of conflict and choice. Society accepts that resolution of such conflict must occur within the political process. This process can be likened to a type of market where participants trade political proposals, rather than goods, and try to maximize objective functions in which votes and power must figure.
prominently. In making their trade-offs politicians are quite willing
to sacrifice efficiency of resource use in order to achieve desired
ends such as income redistribution or the retention and increase of
power. Such trading is the essence of a political system and its
occurrence is an important and indispensable aspect of all societies.
Benefit-cost analysis, by adding to the supply of information available
to this quasi-market, should make it a more effective social instrument.

Of course, it is always relevant to ask if a particular proposal
is the best (most efficient?) way of attaining a particular goal,
regardless of whether that goal is national development, income
redistribution or a political consensus. However, analysis aimed
at answering this question must recognize the institutional and
social constraints which will limit the set of policy alternatives
it is possible to consider. For example, societies such as ours are
a little ambivalent about their pursuit of income redistribution and
usually constrain government to bring it about in certain socially
acceptable ways. The progressive income tax and certain subsidies
through the price mechanism seem to be acceptable but, on the other
hand, in the case of agriculture direct cash grants do not seem to
be acceptable unless the circumstances are exceptional. Economists
need to appreciate this point in their analysis of public investment.

If a programme is being used to redistribute income as well as
to achieve more conventional goals like maximizing national income
growth, then the analysis of the programme in terms of the latter goal
alone will be difficult because of the presence of the former, "non-
efficiency" goal. Conversely, analysis of the efficiency by which
the programme achieves its redistributational goal is complicated by
the presence of the other "efficiency" goal.

This sort of problem poses difficulties for economists who
generally attack programmes which lead to a level of investment
greater than that called for on national income producing grounds.
Such attacks lose some of their relevance if income redistributational
goals, say, are included in the programme and if these goals cannot
be achieved at less cost by means of some other socially acceptable
programme. Economists lose some of their effectiveness in such
circumstances if they fail to recognize that in making their attack
they are implicitly criticizing a value system which prefers a costly
means of redistributing income to a less costly one.

There is a corollary to all this. The existence of public
investment appraisal procedures, and the institutions to use them,
does not necessarily guarantee a high priority to efficiency con-
siderations in selecting projects. This has been demonstrated
strikingly well in Australia recently.

What is more, in the event of a felt need to give efficiency
considerations higher priority than has been customary, the process
of change could seem, to the impatient economist, like a very slow
The Evolution of Benefit-Cost Procedures in the United States

The technique of benefit-cost analysis and its associated jargon seems to be taking the world by storm. The jargon is being used with increasing frequency over an ever-widening range of applications. Its use is so popular that it appears to be supplanting the more conventional terms applied to everyday analysis of economic activity, be it public or private, long-run or short-run.

In contrast to its current prestige, benefit-cost analysis comes from rather humble and special purpose beginnings. In the country of its origin, the United States, the use of benefit-cost...
4.

Analysis tends to be restricted to very specific areas, water and defence, and the possibility of application of the method on a broad front in the public sector has, by and large, been restricted to discussion in the literature of professional economists.

There have been several notable applications of the procedure outside the water and defence fields and some of these have been reviewed by Prest and Turvey (11) and Dorfman (3). However, most of these applications have been on an ad hoc basis and, in my opinion, there is no discernible trend toward the application of such analysis in a broad and systematic way over the whole public sector. While it could be said that the ranking of an array of projects in a homogeneous field, water development, has been attempted in the United States, one cannot claim that such rankings are being attempted in more heterogeneous fields in that country or elsewhere.

Benefit-cost analysis had its beginnings in the civil water programme of the United States Army Corps of Engineers. In one of the few comprehensive reviews of the history of benefit-cost analysis in the United States, Hammond (6, p.3) has pointed out that the procedure is "... in origin an administrative device owing nothing to economic theory and adapted to a strictly limited type of Federal activity - the improvement of navigation".

There is certainly nothing sacrosanct about benefit-cost analysis and it has been said elsewhere by Enke (5, p.viii) that "... most cost-benefit analyses are actually applications of the most simple economic principles ...". Of course, this does not deny the important theoretical problems which have received attention because of the growth in political importance of benefit-cost analysis. Among these problems are those of the social rate of time preference (1), public pricing policies (9, ch.2), and interpersonal utility comparisons (7).

Although Fox (5) refers to an attempt to assess the benefits of transportation programmes in 1808, most authorities regard the beginning of the present century as marking the introduction of evaluation procedures. Hammond identifies 1902 as the year of the introduction of benefit-cost analysis as a procedure for project evaluation and for guidance in the determination of cost shares between Federal and local interests. The procedures used were simple and restricted to direct and tangible costs and benefits of projects.

However, the situation changed during the depression with the greater emphasis on redistributinal policies which characterised the New Deal when these simple evaluation procedures appeared too restrictive. Consequently the Flood Control Act of 1936 directed that benefits of projects be counted "to whomsoever they may accrue", thereby opening the door to the introduction of new concepts of benefits in the secondary and intangible categories.
Perhaps because of this development, the use of benefit-cost analysis spread to other public agencies concerned with water development. However, this should not be interpreted as implying a uniformity of practice among these agencies. In fact, different agencies developed refinements which appeared to suit their particular needs and there was no attempt on the part of the Executive Branch or Congress to enforce uniformity or to evaluate these refinements.

During World War II there was some reaction to this proliferation of procedures and after the war discussion of the matter took place both inside and outside Congress. In 1946 a Federal Inter-Agency River Basin Committee appointed a Sub-Committee on Benefits and Costs "for the purpose of formulating mutually acceptable principles and procedures for determining benefits and costs for water resource projects" (14).

In its report the Sub-Committee suggested a set of uniform procedures which, although welcomed by many, including economists, did not meet with widespread acclaim or adoption by the various agencies. Consequently, criticism of the agencies grew during the 1950's and in 1952 the Bureau of the Budget endeavoured to enforce uniformity by issuing its Circular A-47 (15) to all agencies concerned with water development projects, outlining the standards the Bureau would apply and the procedures it would require the agencies to follow in submitting their reports and budget estimates.

While applying uniform requirements to the agencies, Circular A-47 did not come to grips with the vexing question of secondary benefits and much of the controversy remained. By and large the agencies went their separate ways, although subject to continued sniping. Attempts to change the situation by means of revision and strengthening of Circular A-47 were impeded by hostility from the agencies and Congress1.

The foregoing are merely readily observable details in the turbid waters of United States water politics. In a rather polemical book, Arthur Maass (10) has shown that active concern over Federal water policy dates not from the end of World War II but from the beginning of this century. Articulate concern over Federal participation

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1 Because of confusion outside the United States a few words of explanation concerning the importance of Circular A-47 vis-a-vis the Green Book would be appropriate. The Circular was a directive from an agency of the Executive Branch, the Bureau of the Budget, to the agencies concerned with water development. The Green Book did not have the power which underlay the Circular, being, as it was, merely the report of a sub-committee to an inter-agency committee. Its recommendations were just that: they were not directives. The importance of the Green Book lay in its incorporation of economic, notably welfare economics, principles in its recommendations.
in water resource development can be recognised as being ushered in by President Theodore Roosevelt in his message of transmittal to Congress of the report of the Inland Waterways Commission. The President called for a co-ordinated water policy and commented on how "... (T)he various uses of waterways are now dealt with by bureaux scattered through four Federal departments". The Commission itself recommended setting up a water resources authority to plan and coordinate the work of these bureaux. The lone dissentent from the report was the Chief of the Army Engineers who plumped for the status quo.

Of the various Federal agencies involved in water resource development in the United States the Corps of Engineers is by far the most important. Because of this the dissent of the Chief of Engineers from the Commission report was highly significant. The opposition of the Corps to any proposal to reform the planning of water resource development would not be likely to contribute to the success of the proposal.

Maass defends the thesis that in its civil activities in the field of water development the Corps has been less than a model agency and that over the years it has been a major stumbling block to the implementation of planning reform. His indictment is depressing and persuasive. The Corps is depicted as defending its position by all means possible, including, it is suggested, collusion with individual Congressmen and water development lobbyists. However, in all fairness, it must be pointed out that Maass somewhat simplifies the issue by ignoring such other important attributes of the problem as Federal-State relationships and the division of power between the Executive Branch and Congress.

However, if Maass' book is any guide, it would seem possible to argue that the evolution of formal evaluation procedures in the United States was not symptomatic of a spontaneous move toward "good" government so much as it was the outcome of a feud between the Executive Branch of the Federal Government (the Bureau of the Budget in particular) and other groups, and the Corps and its allies. One is encouraged in holding this hypothesis by the fact that these developments in benefit-cost procedures took place in relation to water resource investment alone rather than on the broad front of public investment as a whole.²

² This is so despite, as has been noted, their widespread use, and discussion of their use, outside the United States and in academic circles in the United States. Furthermore, in this context it could be argued that insistence on the use of objective efficiency criteria in one sector of public expenditure and not in others could lead to a worsening of the total position because of second-best conditions (8).
Developments in the United States since 1959

All in all, despite publication of the Green Book and the release of Circular A-47, and despite the increasing volume of discussion and criticism, it would seem that the problems posed by the excesses of the agencies and their conflicting evaluation standards remained. However, it is likely that the discussion and the publication of evaluation criteria had contributed to a climate of opinion which, given the right conditions, would accept agency co-operation and the comprehensive planning of the nation's river basins. In fact, during the fifties there were several pioneering inter-agency and Federal-State co-operative studies which had suggested the possible direction of change.

The correct set of conditions for a revolt against the old project by project, agency by agency, ad hoc approach to water resource planning was established by the report of the Senate Select Committee on National Water Resources in January 1961.

This Committee was established in 1959 to study the national water situation and, in brief, its conclusions were as follows (13):

"(F)ive major regions in the Nation will have inadequate water supply in 1980 to meet anticipated increases in population and economic activity even with full development:

1. The South Pacific
2. The Colorado River Basin
3. The Great Basin (Utah-Nevada-California)
4. The Upper Rio Grande-Pecos
5. The Upper Missouri River Basin."

By the year 2000 the Select Committee foresaw supply shortages also in the Upper Arkansas-Red River Basins, the Western Great Lakes States, and the Louisiana-Texas western gulf area.

Other major areas of the nation, the Committee said, would have adequate useable water only if they invested billions in pollution control re-cycling, storage reservoirs to level out variable seasonal flows, and to establish more efficient management practices.

The whole great industrial area of the United States from Boston south to Norfolk, Virginia, and then sweeping west in a great band to Kansas City and Sioux Falls, South Dakota, was placed in the latter category.

While there are reasons for having some reservations about these conclusions, it seemed that at least a prima facie case was made which justified more detailed investigation of the future supply and demand for water. This, together with the previously mentioned attempts at planning reform, was sufficient to bring about a major change in the attitude of the United States Federal Government toward the planning of its part in developing the nation's water resources.
The gist of this change was legislation for the creation of machinery whereby Federal and State agencies could co-operate in nationwide comprehensive river basin planning. Although the first bill on the matter came before Congress in 1961, it was not until 1965 that the Water Resources Planning Act was finally passed. Because of this delay President Kennedy in 1962 acted on one of the major provisions of the bill on an ad hoc basis and created the Water Resources Council.

The Water Resources Council consists of the Secretaries of the Interior; Agriculture; Army; Health, Education and Welfare; and the Chairman of the Federal Power Commission. The Council is directed to:

1. Maintain a continuing assessment, at least biennially, of the adequacy of water supplies in each water resource region.

2. Maintain a continuing study of the relation of regional or river basin plans and programmes to the requirements of larger regions of the nation and of the adequacy of the machinery for co-ordination of the water and related land activities of Federal agencies.

3. Appraise the adequacy of existing and proposed policies and programmes to meet national goals.

4. Make recommendations to the President with respect to Federal policies and programmes.

5. Establish, after consultation with other interested bodies and parties, principles, standards and procedures for Federal participants in the preparation of comprehensive plans and the formulation and evaluation of Federal water and related land resource projects.

The wide-embracing responsibilities of the Council should be noted, as also should the emphasis on co-ordinated and comprehensive planning. The Water Resources Council is a co-ordinating body which has the potential to control the activities of the various agencies and to enforce some uniformity in the procedures they follow. After sixty years it seemed that an institution had been created which would put a stop to the special pleading direct to Congress of individual agencies and their congressional supporters and associated lobbyists.

One of the first tasks undertaken by the Council was to comply with directive five above. In May 1962 the results of this work were ordered to be printed as Senate Document 972. This document took up the development of appraisal procedures where the Green Book left off. It also

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3 For example, the Corps of Engineers had its supporting rivers and harbours block, the Bureau of Reclamation had the western block, and the Soil Conservation Service had the farm block.
ranked with and replaced Circular A-47 in authority. Unlike both these other documents, it also had the approval of the relevant agencies and it therefore marked a significant turning point in United States water policy.

Also in 1962 the Council initiated a national programme of comprehensive river basin planning, thereby setting in motion a considerable planning effort involving an anticipated expenditure by 1970 of at least $88 million. Senate Document 97 spelled out the policy framework for comprehensive basin studies as follows (2, p.7):

"1. Reports on proposed plans shall include an analysis of present and projected future economic conditions in the study area and the contribution that comprehensive or project development may be expected to make toward the alleviation of problems and well-being within the zone of influence. Economic projections will be made to provide a basis for appraisal of conditions to be expected with and without the plans under consideration, and an estimate of the contribution that comprehensive development may make to increased national income and welfare, and regional growth and stability. Such analyses will frequently require a general economic study of the area, a study of all of its resources, an assessment of their functional relationships, their development potentials, possible adverse effects, and the locational situation with reference to resources, markets, transportation, climate and social factors. Analyses should indicate the significance of the locality and the region in producing increased goods and services to meet foreseeable needs.

"2. These analyses should be as extensive and intensive as is appropriate to the scope of the project being planned. They should provide essential information for identifying both immediate and long-range needs in economic and social terms and these needs should be expressed in a form useful for program formulation. Presentations in reports should identify:

(a) The relationship between development needs and opportunities and potential water and related land resource use and development;

(b) the economic and social consequences of complete or partial failure to satisfy these needs; and

(c) the possible improvements in economic efficiency, alleviation of unemployment, stabilization of production and income, community well-being, and the quality of goods and services that will be forthcoming."

The Water Resources Council defined three types of investigation to implement this policy. They are:
10.

1. Type I, or framework studies which are intended to furnish a general appraisal of overall water and related land resource development needs and serve as a guide to further detailed planning within the sixteen water resource regions of the continental United States. The scope of these studies is broad and provides for a general analysis of the region involving:

   (a) Economic projections as a basis for forecasting future economic activity in quantitative terms;
   (b) translation of these projections into demands for water and related land resource uses;
   (c) analysis of the basin hydrology - to estimate available water supply by sub-basins or major river reaches;
   (d) projections of related land resource availability; and
   (e) identification of significant problems and possible general approaches for their solution.

2. Type II surveys which provide for a general appraisal of overall water and related land resource development involving long-run projections into demands for water and related land resource uses, hydrologic projections of water availability, both as to quantity and quality, and projections of related land resource availability similar to the Type I studies. In addition, the Type II studies define and evaluate the Federal or Federally assisted projects for which Federal authorisation will be required to permit necessary construction to be initiated in the next ten to fifteen years in sufficient detail to comprise a basis for authorisation. It would seem that it will be in the Type II studies that the results of co-ordinated comprehensive planning will come together in the evaluation of Federal investment alternatives.

3. Type IV co-operative surveys are those being made by a State water agency in which a Federal agency is co-operating.

**Benefit-Cost Analysis in Australia**

The Australian constitution gave power over most matters to the States. The Federal body was given exclusive powers over customs and excise duties, currency and coinage, defence, external affairs and territories. There are also some powers held concurrently by both State and Commonwealth. However, the powers of the States are, in some important areas, more apparent than real. The Commonwealth has come to assume such a dominating position in the financial arena that Federal thinking is often a chief determinant of State policy in matters exclusively within the State Government's domain in terms of the constitution.
The path to Federal financial dominance has been highlighted by three distinct events:

1. Surrender by the States of authority to impose customs and excise duties at Federation;

2. Entry by the Federal and State Governments into the Australian Loan Council with agreement by the States to forfeit their rights to pursue independent borrowing programmes in 1929; and

3. Exclusion of the States from the field of income taxation in 1942.

The Loan Council determines the volume and distribution of all Government borrowing apart from that for defence purposes. The decisions of the Council are by majority vote, with the Commonwealth having two deliberative votes and a casting vote and each State one vote each. Failing a unanimous decision on the allocation of the total amount between member Governments, the Commonwealth is entitled to one-fifth of the total and each State to a proportion of the remainder.

The Loan Council funds allocated to each State for capital works are supplemented by special purpose Commonwealth grants which have become increasingly important in recent years. These special purpose grants have been for a variety of purposes ranging from universities through to beef roads. More and more State agricultural development projects have been financed by such grants and it is interesting to note that, as a condition for success by a State in applying for a grant, the Commonwealth is insisting on an economic analysis of such agricultural schemes. No such economic analysis is necessarily carried out on projects financed from Loan Council funds.

Financing projects through the Loan Council is a cumbersome process but one relatively free of critical economic scrutiny. This contrasts with the land development projects which have been the subject of special purpose grants. It should be noted, however, that not all special grant projects are subject to such appraisal. However, among those that have been we have: The Brigalow Scheme in Queensland; the Craigieburn Irrigation Scheme in Tasmania; road development in the Northern Territory Buffalo Area; and the Comprehensive Water Supply Scheme in Western Australia. Unpublished reports have also been prepared on the Ord River Scheme and the Emerald Scheme as well as the Commonwealth-State softwood forestry planting programme. All told, apart from the forestry study, the total potential capital cost of these schemes is $400 million. It should also be noted that these analyses, while done by the Commonwealth, were done so on behalf of the States, except for the buffalo study. If reports are suppressed, and some are, then it is the States which elect to do so. It is freely rumoured that Queensland, being unhappy with the results of some of the Commonwealth analyses, has decided to do these studies.
using its own resources. However, it can be argued that some of this State dissatisfaction is rational even though it may not be desirable from a national viewpoint.

The use of benefit-cost analysis in Australia has been given some impetus by the initiation of a National Water Resources Development Programme this year. In his policy speech of last year the Prime Minister intimated that a water conservation programme related to national needs would be drawn up jointly by the Federal and State Governments. He indicated that the purpose of the programme was to increase water conservation activity to reduce hazards of drought and expand primary production. Projects mainly for urban purposes or hydro-electric power generation would not be included in the programme. Mr Holt envisaged a programme of works to be selected on their merits which would be additional to the current level of State rural water conservation works. The Commonwealth would contribute $50 million over five years in the form of grants.

One could be a little cynical about this proposal when the small amount of money involved is considered and the fact that the proposal was announced in a time of drought is appreciated. To some the proposal looks something like a vote-catching scheme capitalising on the "irrigation cargo cult" which is endemic in Australian society and which has been very articulate as a result of the recent drought.

However, cynicism aside, the proposal is most interesting. If it works, this will be the first time in Australia an attempt to allocate priorities to public works on national economic grounds will have succeeded. There have been several such attempts at this previously but all have failed. Perhaps this will succeed because here the Commonwealth has an inducement it has not had available to it before, namely the cash grants. The States have previously surrendered some of their jealously guarded sovereignty in regard to such investment decisions only in similar circumstances, i.e. when a cash grant was possible.

The proposal is perhaps even more interesting because it represents the first attempt in Australia to establish priorities between a set of public investment alternatives by means of economic analysis. As we have seen, all previous applications of benefit-cost analysis have been strictly on an ad hoc individual project basis.

However, one's expectations should not be raised too high; it is very early in the piece for the scheme yet and I can envisage a situation where political tensions and inter-state rivalries could split the proposal asunder, with allocations being determined by political horsetrading rather than efficiency-based priorities, all done, of course, in the best Australian tradition "in camera".
Conclusion

For the purposes of this symposium I am perhaps not the best person to draw the relevant conclusions from this paper. However, there are several points I should make:

1. It is important to note how the federal system tends to dominate and distort the fundamentally important issues in Australia. New Zealand, with its unitary, centralist government, should at least be able to escape this problem.

2. While the problems posed by a federal structure are significant in the United States, they do not dominate the position as they do in Australia. The problem for the United States has, if anything, been that of excessive power and independence of major federal water development agencies. The lesson to be learned from this is that the analysis of public investment projects should be made the responsibility of an agency which is independent of any construction authority.

Finally, I would say the over-riding lesson from my paper is that the intention to establish higher priorities for economic analysis of public investment projects needs to be accompanied by the intention to create institutions and conditions which will ensure effectiveness of the analysis. Outstanding among these needed conditions are, as mentioned above, real independence for the investigating authority from any agency which has a vested interest in the proliferation of major public investments such as forests, roads, and dams; and public awareness of the economic and non-economic choices involved in particular public investment proposals.

The allocation of public investment funds must be left to the political process; this is indisputable. It would be contrary to our philosophy of state to argue that this allocation should be determined by a mindless process of "objective" economic analysis. However, there is no denying the value of such analysis to the decision process, not only because it promotes efficiency of resource use, but also because it makes it necessary for the electors and the elected to be more articulate and thoughtful about their preferences for themselves and for their society.
References


It is a regrettable, but unfortunately hardly controvertible fact, that throughout the 'fifties and early 'sixties New Zealand had one of the lowest rates of growth in the Western world. From those halcyon days when Mr Colin Clark rated this country second only to the United States in the international league tables, we have gradually slipped to a position where even Dr Sutch ranks us only fifth and many a less optimistic economist, with a doubtful eye on the true value of the $NZ, may be forgiven for wondering if we are still in the first ten. It is true that in the mid-sixties there was a spurt when the growth rate reached gross figures of 9.4% in 1963/64, 9.0% in 1964/65 and 7.7% in 1965/66. Even when allowance is made for the fact that these increases in gross national product are measured at current prices, and that both the labour force and the total population were growing at almost 2 per cent per annum, these remain respectable figures. They may be attributed primarily to what now appears as a spectacular level of overseas prices for our pastoral products, together with a rather unseemly level of overseas borrowing. The collapse of the wool market, together with minor recessions in the prices of meat and dairy products, have necessitated fairly drastic restraints upon aggregate spending within the economy and the growth rate accordingly fell back to 5.4% in 1966/67.

Much discussion on growth theory has concentrated on capital formation and its productivity. The rate of gross capital formation in New Zealand has averaged 22 per cent of gross national product over the last ten years (Table 1). This is well below the spectacular levels of around 40 per cent recorded for Japan, but is comparable with that of many other countries who have achieved higher rates of growth. This suggests that it is upon the productivity of capital that attention should be focussed.

There are two aspects of productivity: firstly, the areas into which investment is channelled, and secondly, the efficiency with which capital is used in those areas. A feature of capital formation in New Zealand has been the relatively large flow into building construction in the private sector. The data given in Table 2 show that throughout the period, residential and commercial construction has accounted for one third of total investment, or approximately 8 per cent of gross national product. Moreover, a great deal of the investment carried out by local authorities (which itself accounts for 15 per cent of total investment) has been to provide ancillary services for urban purposes. These proportions are very high by world figures, and in marked contrast to Japan where the standard of housing and other social amenities remains low, while emphasis is placed on investment in plant and equipment.¹

<table>
<thead>
<tr>
<th>Year ending 31 March</th>
<th>Gross national product</th>
<th>Private sector investment</th>
<th>Public sector investment</th>
<th>$ million</th>
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<tr>
<td></td>
<td>G.I.</td>
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<td>Central government</td>
<td>Per cent</td>
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<tr>
<td></td>
<td>Building</td>
<td>Other</td>
<td>Total</td>
<td>Per cent G.N.P.</td>
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<tr>
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<td>115</td>
<td>256</td>
</tr>
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<td>124</td>
<td>290</td>
</tr>
<tr>
<td>1960</td>
<td>2434</td>
<td>181</td>
<td>116</td>
<td>297</td>
</tr>
<tr>
<td>1961</td>
<td>2622</td>
<td>209</td>
<td>157</td>
<td>366</td>
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<td>1962</td>
<td>2721</td>
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<tr>
<td>1963</td>
<td>2924</td>
<td>202</td>
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<tr>
<td>1964</td>
<td>3200</td>
<td>243</td>
<td>187</td>
<td>430</td>
</tr>
<tr>
<td>1965</td>
<td>3483</td>
<td>274</td>
<td>223</td>
<td>497</td>
</tr>
<tr>
<td>1966</td>
<td>3736</td>
<td>299</td>
<td>254</td>
<td>553</td>
</tr>
<tr>
<td>1967</td>
<td>3937</td>
<td>N.A.</td>
<td>N.A.</td>
<td>561</td>
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</tbody>
</table>

Source: Economic Survey 1967, p.54
### TABLE 2  GROSS CAPITAL FORMATION IN NEW ZEALAND 1957/1962 (2)

<table>
<thead>
<tr>
<th>Year ending 31 March</th>
<th>Private sector investment</th>
<th>Public sector investment</th>
<th>Total investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Building</td>
<td>Per cent total I</td>
<td>Other</td>
</tr>
<tr>
<td>1957</td>
<td>191</td>
<td>31</td>
<td>115</td>
</tr>
<tr>
<td>1958</td>
<td>166</td>
<td>33</td>
<td>121</td>
</tr>
<tr>
<td>1959</td>
<td>166</td>
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<tr>
<td>1960</td>
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<td>1962</td>
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<td>1965</td>
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<td>1966</td>
<td>299</td>
<td>33</td>
<td>254</td>
</tr>
<tr>
<td>1967</td>
<td>N.A.</td>
<td>N.A.</td>
<td>561</td>
</tr>
</tbody>
</table>

Source: *Economic Survey 1967*, p.54
New investment in residential housing, which is a large component in private investment, reflects a real rise in welfare but it does not lead to that cumulative growth of productive capacity which is characteristic of investment in plant and machinery.

A feature of capital formation in this country is the relatively large proportion which is carried out in the public sector. In the last few years this has averaged almost 40 per cent of total investment, representing nine per cent of gross national product. Investment by the central government accounts for 25 per cent of total capital formation, and the local authorities account for a further 15 per cent. Table 2 illustrates that although investment in the public sector is still high it has declined as a proportion of total capital formation over the past ten years, from 44 per cent in 1957 to 39 per cent in 1967. Local authority expenditure has remained remarkably constant at 14 - 15 per cent but investment by the central government has declined from 30 per cent to 25 per cent. On the other hand, private investment, particularly in the category, 'other than building', has risen in relation both to G.N.P. and to total investment. It is interesting to record as a corollary to this changing pattern in investment, that there has been a similar change in the source of capital funds. Despite the much publicised borrowing by the government in the last few years, the proportion of overseas capital raised in the form of government loans has declined in relation to the proportion of private investment, much of which takes the form of reinvestment of profits earned by subsidiaries of overseas firms. In spite of this gradual trend, investment in the public sector, and particularly by the central government, remains a most significant component in total capital formation in this country, and it is with this that I am primarily concerned in this paper.

Investment by the central government may be divided into two broad categories - that carried out by or for the trading departments such as the railways, the national airline or the production of electricity power, and that carried out for non-trading departments such as, health, education and defence. Unfortunately, I am not able to quote individual figures for separate departments but Table 3 shows a broad classification of government capital expenditure over recent years. Over the last decade the biggest claimant on capital funds has been electric supply development: expenditure in this field reached $65.8 million in 1966, 30 per cent of government capital formation. Other important components were roads and highways at $27.8 million and education buildings at $27.4 million. Investment in these three areas had increased since 1963 by 78 per cent, 86 per cent and 26 per cent respectively, while in total government capital expenditure over this period increased by 41 per cent.

Turning to those areas of expenditure in which this meeting is likely to be particularly interested, capital expenditure by the government in land conservation and development has increased very little during the decade, from $8 million in 1960 to $9.2 million in 1966, while in real terms it has actually fallen. Expenditure on forestry development, which by 1966 was on virtually the same scale as land development for agriculture,
### TABLE 3 GOVERNMENT CAPITAL EXPENDITURE - 1960/66

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<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Housing</td>
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<td>20.2</td>
<td>18.4</td>
<td>16.6</td>
<td>16.8</td>
<td>15.4</td>
<td>14.6</td>
</tr>
<tr>
<td>Electric supply</td>
<td>35.0</td>
<td>36.4</td>
<td>36.0</td>
<td>37.0</td>
<td>48.6</td>
<td>54.4</td>
<td>65.8</td>
</tr>
<tr>
<td>development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Railways</td>
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<td>12.2</td>
<td>13.4</td>
<td>13.0</td>
<td>16.4</td>
<td>16.8</td>
<td>17.0</td>
</tr>
<tr>
<td>Land conservation</td>
<td>8.0</td>
<td>8.6</td>
<td>8.6</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>9.2</td>
</tr>
<tr>
<td>and development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post and telegraph</td>
<td>12.4</td>
<td>12.0</td>
<td>13.4</td>
<td>14.4</td>
<td>14.8</td>
<td>16.0</td>
<td>16.8</td>
</tr>
<tr>
<td>extensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roads and highways</td>
<td>16.4</td>
<td>16.4</td>
<td>13.6</td>
<td>14.8</td>
<td>19.8</td>
<td>20.2</td>
<td>27.8</td>
</tr>
<tr>
<td>Education buildings</td>
<td>15.8</td>
<td>16.8</td>
<td>18.6</td>
<td>20.2</td>
<td>22.8</td>
<td>25.6</td>
<td>27.4</td>
</tr>
<tr>
<td>Forest development</td>
<td>4.0</td>
<td>6.2</td>
<td>5.4</td>
<td>5.8</td>
<td>6.4</td>
<td>8.4</td>
<td>9.0</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>15.2</td>
<td>18.0</td>
<td>20.0</td>
<td>22.8</td>
<td>25.4</td>
<td>30.4</td>
<td>29.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>139.4</td>
<td>146.8</td>
<td>147.4</td>
<td>153.4</td>
<td>179.8</td>
<td>196.0</td>
<td>217.4</td>
</tr>
</tbody>
</table>

Sources:  
60/61 Economic Survey 1963, p.41  
62 Economic Survey 1966, p.61  
63/66 Economic Survey 1967, p.56
has doubled over this period. (It should be born in mind, however, that from 1962 the government has encouraged, through the Agricultural Development Conference, a massive expansion of land improvement and increased stocking on private farms.)

It might be thought that with a large proportion of capital investment concentrated in the public sector New Zealand would be a haven for the practitioner of cost-benefit analysis. This, however, is not true as yet. Indeed it is only comparatively recently that the technique has been applied, and it seems probable that its widest use is in agriculture. The nature and organisation of this symposium supports this belief. There have, however, been a number of major evaluation studies, though not cost-benefit studies, in other sectors of the economy: outstanding examples are those conducted for the steel mill at the Waikato Heads, and for the Manapouri and Tongariro electric power development schemes.

I should like to be able to present an account of project evaluation studies in a number of areas of the public sector, but, unfortunately, am not yet in a position to do so. The Seminar on Project Evaluation, which we are to hold at the University of Waikato next week, will include papers on investment studies for electric power development, roading, regional development and town planning. It is hoped to supplement these with an account of the work of the Treasury planning unit. However, a comparative study of techniques used, problems encountered and results obtained in these areas lies ahead. For the rest of the present paper I want to turn to certain aspects of evaluation studies which I think are particularly suitable for discussion at this Conference. They are: the relationship between project evaluation and cost-benefit analysis, the rate of interest to be used in empirical studies in New Zealand, and the treatment of overseas earnings.

Project Evaluation and Cost-Benefit Analysis

It is necessary to distinguish between cost-benefit analysis per se and project evaluation. There appears to be some confusion between the two, indeed they are sometimes taken as one and the same thing. The confusion has probably arisen because the discounted cash flow technique was introduced at an early stage into cost-benefit analysis, with which it has become closely identified. Discounted cash flow has been extended to other forms of investment analysis in recent years with the result that these have become loosely labelled cost-benefit analysis. The distinguishing feature of cost-benefit analysis is not the method of handling the problem of time, but the fact that it specifically takes externalities into account, and by so doing, encompasses a wider viewpoint than other forms of project evaluation carried out from the more restricted viewpoint of an individual firm, a public corporation or even a government department wedded to a conventional notion of profitability. In brief, cost-
benefit analysis may be regarded as a species of the genus project evaluation.

Professor Williams has suggested that all firms are concerned with costs and benefits so that the private firm has always, unknowingly perhaps, indulged in cost-benefit analysis. It seems to me that this approach confuses the issue. I prefer to restrict the use of the phrase cost-benefit analysis to those investment studies which specifically take into account (Pigovian) social costs and benefits and to retain the concepts of revenue or returns and costs for studies which exclude externalities. If we accept this distinction then it follows that the analysis of individual farm development schemes should not take the form of, and should not be described as, a cost-benefit study, whereas the study of a regional irrigation scheme, or of a catchment area conservation scheme, do fall within this category.

The Rate of Interest in Empirical Studies

If either present worth or a cost-benefit ratio is used as the criterion of investment, then a rate of interest or discount has to be selected. Obviously, the rate chosen will have a pronounced effect upon the result of the evaluation; projects which appear worth while at one rate of interest may not be so at another, higher rate, while the ranking of projects with different time patterns may be affected by the rate selected. The selection of a rate of interest for use in public investment analysis remains a matter of controversy. Amongst the economic theorists there are advocates for the social rate of time preference, which is assumed to differ from the private rate, and also for the opportunity cost rate, or marginal efficiency of capital. The new welfare economists point out, however, that the marginal efficiency of capital may vary for investment in the public sector and in the private sector, so that public investment decisions based on its value in the former could lead to sub-optimal solutions.

As in some other branches of economics we find a gap between the solutions of the theorists and the application of the practitioners. Most empirical studies, prefaced by a brief discussion of the difficulty of selecting a suitable rate of interest, end up by employing the rate of interest on long-term government bonds. Moreover, there seems to be a natural tendency for most writers to select rates of 5 - 6 per cent, as though, subconsciously perhaps, this is regarded as the long-term rate of interest. In an earlier paper I suggested that as a rule of thumb measure in this country, we might use the rate of interest on development bonds for domestic capital and that on overseas loans for foreign capital. I did not then say how to differentiate between these two classes of capital. Virtually every major development project in this country has some import content and this is known to be large in the case of the outstanding capital users, electricity power development and

road and highway development. The mix of imported and domestic inputs into a project would not raise difficulties if the internal and overseas borrowing rates were similar but in fact these now differ widely. This divergence may be typified by the two loans floated this month: one in London for $15 million issued at £98 with a coupon of 73⁄4 per cent giving a yield to redemption, 1988-92, of 7¾-7½d. (As is well known, it was undersubscribed with 81 per cent of the issue left with the underwriters, and is currently, late November 1967, selling at a small discount.)

The second is the new internal loan, for an unspecified amount, issued at par, with a yield of 5 per cent (1970), 5¼ per cent (1973) and 5¾ per cent (1983).

The yield gap of 2 per cent between New Zealand loans issued on the home market and those issued in London raises a number of interesting points, many of which lie outside the scope of the paper. Of direct significance is the question of whether the internal or the external borrowing rate should be used for project evaluation. It seems probable that government departments carrying out their own evaluation use the internal borrowing rate, although this is not perhaps consistent with the repeated statements of Cabinet ministers justifying heavy overseas borrowing on the grounds that the funds have been used to build up capital assets within the country. The logic of these statements is that the projects into which the overseas funds have been directed should yield at least sufficient to cover the overseas borrowing rate, but to the best of my knowledge this conclusion has never been drawn in any of the Ministerial statements. I am left with the impression that investment in New Zealand is thought to be a good thing in itself irrespective of how the yield on that investment compares with the overseas cost of borrowing. Indeed, I sometimes wonder whether this aspect has ever been considered.

Of immediate concern for this meeting is which of these borrowing rates should be used for evaluating a project. One solution would be the overseas rate, to give particular emphasis to the restraint imposed by the shortage of overseas loan capital. Another might be a weighted average with the two rates weighted according to the proportions of foreign to domestic capital. This is an issue which this symposium could well discuss.

Project Evaluation and Export Earnings

Many capital intensive projects in New Zealand have been justified in the past by a sweeping reference to their contribution to export earnings, or to its close relative, import replacement. I believe that these concepts have been accepted too uncritically in the past and that, as a result, a great deal of unwarranted investment has taken place in New Zealand. The ultimate criterion of investment ought to be its potential contribution to the real growth of the economy. Nevertheless, in the present economic state of the country, foreign exchange is the most important restraint on our economic growth, and
potential contribution to overseas funds should clearly be one, though not the only criterion, adopted in project evaluation.

Although export earning, or import replacement, have been stressed sometimes in rather naive terms, in many cases of development, it has rather surprisingly not received a great deal of attention in a number of recent studies on agricultural development, including several made by this College. One such study, of the development of North Island pumice country, was made by Mr E.D. Parkes and myself, together with Mr M.B. Grainger and Mr R.T. Fenton of the N.Z. Forest Service. This was essentially an investment study using a discounted cash flow analysis. It was not a cost-benefit study; although specific attention was paid to social costs of housing and road, no account was taken of externalities. It had a further limitation in that outputs were evaluated on a farm gate and forest ride basis. Now this basis can be justified on theoretical grounds, if we assumed an approximation to competitive equilibrium conditions, and I have had to justify it on several occasions to members of the Forest Service, who not only believe that processing is more significant for forestry than agriculture, but are also highly sceptical about theoretical states of equilibrium. I have now carried out a rather tentative exercise in an attempt to take the results of the Maraetai study beyond the farm gate. Mr Grainger has extended the analysis for forestry in a similar way.

Agriculture - Farm Gate and f.o.b. Values

Valuing the output from a block of agricultural land in terms of export earnings raises a number of difficulties. Foremost among these is the fact that the physical transformation of the product means that, with the exception of wool, it is not possible to compare like with like at farm gate and f.o.b. The processing of milk to butter and cheese, and of sheep and cattle on the hoof into carcasses, gives rise to a large number of by-products - casein, pelts, hides, tallow, etc., which are not covered under the export items - butter, lamb, sides of beef, - but which do contribute to overseas earning and ought therefore to be taken into account in an investment analysis. The significance of by-products means that it is not sufficient to convert units of stock at the farm gate into carcasses at f.o.b.; a rather wider approach needs to be adopted. For this purpose, detailed information about physical conversion rates and by-products, in addition to costs of processing, were sought from a major dairy company and a number of meat companies. Sufficient data were obtained from the dairy company to enable estimates to be made of the value added by processing butterfat-in-milk. It has been assumed that these estimates are broadly representative for the industry as a whole, as the company concerned is the largest in the country.

With regard to stock slaughtered for export, much greater difficulty was experienced in estimating value added, due to the number of processes, the range of by-products and the sale of final products over some seventy different markets. Discussions with two major meat companies in South Auckland met the response that to obtain figures with any degree of realism
"would be a major task involving considerable time". In order to obtain some estimate, however broad, it was decided to value wool on a realised F.O.B. basis and stock for slaughter on a 'farm gate plus processing charge' basis. The meat companies pointed out that their processing charges take some account of the value of by-products but it seems probable that valuing exports on the basis of 'stock at farm gate plus processing charges' understates the real value of overseas earnings.

Store stock also raise a difficult problem in that they make no direct contribution to overseas earnings in the year in which they are sold but do so only after fattening, or being used as breeding stock, on other farms. One possible approach would be to value such stock for slaughter, i.e. taking store lambs and weaners on a weight basis, but this was rejected in favour of valuing them at market price, which is assumed to give a reasonable, though conservative, indication of their potential earning in overseas funds.

Dairy Block

(i) Butterfat-in-milk

Conversion of farm gate to F.O.B. values for butterfat was carried out by two methods in order to provide a check.

(a) Value added: the value added by processing butterfat in whole milk to butter and casein was 10.02d. per lb of butterfat in 1962/63. Butterfat in whole milk was priced at 36.25d. per lb in 1962/63 so the output of butter and casein was valued at 46.27d. per lb. butterfat F.O.B.

F.O.B. value 2,166,000 lbs butterfat in whole milk
at 46.27d. per lb £18,000

(b) Physical quantities: after allowing for a 1.2% loss on separation butterfat was converted to butter at a factor of 1.2143. Skim milk was converted to casein on the basis of 3,600 lbs of butterfat in whole milk to a ton of casein. Using these conversion factors and applying 1962/63 prices gives:

Butterfat in whole milk 2,166,000 lbs
Converted to:
Butter 2,590,000 lbs
at net F.O.B. price of 29.663d. per lb £320,000
Casein converted to 600 tons
at F.O.B. value £130/ton = 78,000
Total revenue from butter and casein 398,000
say £400,000
Bobby calves

It is estimated that 4,216 bobby calves would be sold off the block at a farm gate value of £10,100. All these calves are sold through Bobby Calf Pools and realisations less costs of transport and processing are returned to the farmers. In 1962/63 nearly all bobby calves were exported as veal and additional revenue was realised for skins. Value added was calculated at £1-4-2 a head (£1-0-11 for processing plus 3/3 for collection and administration). The farm gate value was £2-8s. a head (including 4/- bonus); together with the value added this gives a grossed up value of £3-12-2 f.o.b.

Total revenue 4,216 calves at £3-12-2 £15,200

Cull cows

Cull cows and heifers from the Jersey herds on the dairy block are transported at 17/- a head. Processing is estimated to cost 3.9d./lb and the culls are estimated to average 350 lbs carcase weight. Value added after the farm gate is £6-4s. giving a grossed up value of £21-14s. f.o.b.

Total revenue 1,632 cull cows and heifers at £21-14s. £35,000

Sheep Block

Wool

It was estimated that the total sale of wool off the Maraetai block would be 720,000 lbs and that this would realise for the farmer 36d. per lb net of shearing and selling. Selling, reclassing where necessary, and scouring of some part of the wool clip are among the main processes adding value to wool for export. The unit value of all (greasy, scoured, slipe) wool exports for 1962/63 was 44.62d. per lb f.o.b. Assuming that the wool off the Maraetai block approximated to the national average both in terms of the processing involved and in quality, and applying this figure to the wool clip from the block, gives:

Total revenue 720,000 lbs at 44.62d. £134,000

Fat lambs

Data provided by the N.Z. Meat and Wool Board's Economic Service gave a value added figure of 8/11 per head (1/1 transport and 7/10 processing) for fat lambs in the 1962/63 season. Applying this to the 25,000 lambs sold off the Maraetai block gives an aggregate value of
approximately £11,000 and adding this to the farm gate value of £56,700 gives a grossed up value of £68,000 f.o.b.

\[
\begin{align*}
\text{Total revenue} & \quad 25,000 \text{ fat lambs at 54/-} & \quad £ 68,000
\end{align*}
\]

(iii) Cull ewes

It is estimated that 10,000 cull ewes a year will be turned off the block. Transport charges to the freezing works were 1/10d. a head and processing charges 2.8d. per lb, which, at an average weight of 47 lbs, amounts to 11/- a head. Total value added after the farm gate is 12/10d. giving a grossed up value of 28/- f.o.b.

\[
\begin{align*}
\text{Total revenue} & \quad 10,000 \text{ cull ewes at 38/-} & \quad £ 19,000
\end{align*}
\]

(iv) Cull cows

Cull cows from the run cattle are sold at an average of £22-10s. at the farm gate. Transport costs to the works are 17/- a head and processing costs, at 3/9d. per lb for beasts killing out at 450 lbs, total £7-3s. Grossed up values are £30-10s. a head.

\[
\begin{align*}
\text{Total revenue} & \quad 700 \text{ cull cows at 30-10s} & \quad £ 21,350
\end{align*}
\]

Dairy block (10,000 acres)

<table>
<thead>
<tr>
<th>Product</th>
<th>Physical output</th>
<th>Value</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Farm gate</td>
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<tr>
<td>Butterfat (lbs)</td>
<td>2,166,000</td>
<td>327,150</td>
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<tr>
<td>Bobby calves</td>
<td>4,216</td>
<td>10,100</td>
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<tr>
<td>Cull cows and heifers</td>
<td>1,632</td>
<td>25,400</td>
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<td>£372,650</td>
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</table>
Sheep Block (15,000 acres)

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<th>Value</th>
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<tr>
<td></td>
<td></td>
<td>Farm gate £</td>
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<tr>
<td>Wool (lbs)</td>
<td>720,000</td>
<td>108,900</td>
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<tr>
<td>Fat lambs</td>
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<td>56,700</td>
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<td>Store lambs</td>
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<td>6,800</td>
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<tr>
<td>Cull cows</td>
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<td>15,800</td>
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<tr>
<td>Beef weaners</td>
<td>3,400</td>
<td>48,000</td>
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<td></td>
<td>£257,500</td>
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<td>TOTAL</td>
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<td>£630,150</td>
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Assumptions: high productivity, moderate prices.

For forestry the assumption is that all pulpwood will be purchased by a pulp and paper mill located at Kinleith, and that all sawlogs will go to a sawmill at Tokoroa. In both cases it is assumed that if the processing plants have to provide accommodation for their employees such accommodation will be let at rentals which at least cover all expenses, including interest. Roading is not involved - hence the economic analysis logically excludes all social costs. All products are assumed to be railed to Mt Maunganui for export to Australia; and it is assumed that the Kaimai rail tunnel has shortened the rail distance to not more than 85 miles.

Pulp and Paper

Broadly speaking, there are two possibilities: processing and export in the form of unbleached air-dry sulphate pulp, or alternatively as Kraft paper sacking. By virtue of the Australia-N.Z. Free Trade Agreement, Kraft paper sacking promises to be a highly profitable line whereas unbleached pulp shows a very poor level of profit. From a practical stand-point it is logical to assess the economics of processing pulpwood on the basis of 50% Kraft paper sacking.
and 50% unbleached sulphate pulp. Tables 4 and 5 trace the cash flow for pulp and paper processing from the commencement of pulpwod production in year 20 until stabilisation of the pulpwod yield in year 41. These two tables each treat the pulpwod yield as if it were processed entirely into unbleached pulp (Table 4) or alternatively entirely into Kraft paper sacking (Table 5). The assumption is that to produce 100,000 tons of pulp and paper per annum the capital cost of plant and buildings would be:

<table>
<thead>
<tr>
<th>Product</th>
<th>Capital investment</th>
<th>Annual net profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulp only</td>
<td>£12,000,000</td>
<td></td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>£15,000,000</td>
<td></td>
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</tbody>
</table>

Column 3 of each table allocates these capital charges pro rata with the available pulpwod supply.

Profitability of Pulp and Paper

At no stage is the pulpwod supply from Maraetai sufficient to satisfy a pulp and paper mill of 100,000 tons capacity per annum; so the assumption is made that adequate supplies of pulpwod are available from other forests to lift the total mill input to the requisite 17 million cubic feet per annum. A summary of the operating position from year 41 onwards is as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Capital investment</th>
<th>Annual net profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unbleached pulp</td>
<td>£2,300,000</td>
<td>£146,000</td>
</tr>
<tr>
<td>Kraft sacking</td>
<td>£2,900,000</td>
<td>£900,000</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>£2,600,000</td>
<td>£523,000</td>
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</table>

Sawn Wood

Export prices for sawn wood are lower than domestic prices; hence because the log supply has been costed into the sawmill at local market rates the processing of sawn wood for export is a marginal undertaking. The wood is exported on a "rough sawn and unseasoned" basis, and, as Table 6 shows, the net annual profit from year 41 onwards is only 5% on the capital investment (standard profit on sawmilling being 15%).

Note: In the case of both pulp and paper and also sawn wood, all profits are shown before tax. Production of sawlogs does not commence until year 38, and, as production is constant from then onwards, the annual cash flow is constant apart from the capital outlay of £400,000 in year 37/38. (Table 6.)
### TABLE 4: PROCESSING OF THE PULPWOOD YIELD INTO UNBLEACHED SULPHATE PULP FOR EXPORT TO AUSTRALIA

<table>
<thead>
<tr>
<th>Year</th>
<th>Total pulpwood supply (million cu.ft.)</th>
<th>Pro rata cost of plant and equipment (£ million)</th>
<th>Cost of pulpwood at forest (£)</th>
<th>Cost of transport to mill (£)</th>
<th>Cost of wood at mill (£)</th>
<th>Cost of processing (£)</th>
<th>Transport and sales expenses (£)</th>
<th>Total cost f.o.b. (£)</th>
<th>Total sales value on processing (£)</th>
<th>Profit on processing (£)</th>
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<td>20</td>
<td>1.43</td>
<td>1.0</td>
<td>59,000</td>
<td>26,000</td>
<td>85,000</td>
<td>207,000</td>
<td>36,000</td>
<td>328,000</td>
<td>375,000</td>
<td>47,000</td>
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<tr>
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<td>3.7</td>
<td>202,000</td>
<td>96,000</td>
<td>298,000</td>
<td>760,000</td>
<td>131,000</td>
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<td>1,380,000</td>
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<td>Year</td>
<td>Total pulpwood supply (million cu.ft.)</td>
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<td>Cost of transport to mill (£)</td>
<td>Processing into kraft sacking</td>
<td>Total Sales Value f.o.b. (£)</td>
<td>Profit on processing (£)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>6.40</td>
<td>5.6</td>
<td>222,000</td>
<td>117,000</td>
<td>339,000</td>
<td>1,470,000</td>
<td></td>
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<tr>
<td>32</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>6.60</td>
<td>5.8</td>
<td>232,000</td>
<td>121,000</td>
<td>353,000</td>
<td>1,520,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>6.20</td>
<td>5.5</td>
<td>217,000</td>
<td>114,000</td>
<td>331,000</td>
<td>1,420,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>5.20</td>
<td>4.6</td>
<td>197,000</td>
<td>95,000</td>
<td>272,000</td>
<td>1,190,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>37</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>3.45</td>
<td>3.0</td>
<td>109,000</td>
<td>63,000</td>
<td>172,000</td>
<td>797,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>3.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>3.18</td>
<td>2.8</td>
<td>96,000</td>
<td>58,000</td>
<td>159,000</td>
<td>730,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41 and on</td>
<td>3.25</td>
<td>2.9</td>
<td>98,000</td>
<td>60,000</td>
<td>158,000</td>
<td>745,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 5: PROCESSING OF THE PULPWOOD YIELD INTO KRAFT SACKING FOR EXPORT TO AUSTRALIA
### TABLE 6: PROCESSING OF THE SAWLOG YIELD INTO ROUGH SAWN WOOD FOR EXPORT TO AUSTRALIA

Total sales value of sawn output:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20 million bd. ft at 76.5 shgs. per 100 F.O.B.</td>
<td></td>
<td>£765,000</td>
</tr>
<tr>
<td><strong>Less expenses:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of sawlogs ex forest</td>
<td>£391,000</td>
<td></td>
</tr>
<tr>
<td>Cost of transport to sawmill</td>
<td>58,000</td>
<td></td>
</tr>
<tr>
<td>Cost of processing (green basis)</td>
<td>190,000</td>
<td></td>
</tr>
<tr>
<td>Cost of Transport to port</td>
<td>97,000</td>
<td></td>
</tr>
<tr>
<td>Cost of wharfage and inspection</td>
<td>9,000</td>
<td></td>
</tr>
<tr>
<td><strong>Annual Sawmilling Profit</strong></td>
<td></td>
<td>£20,000</td>
</tr>
<tr>
<td>Capital investment required for a sawn output of 20 million bd. ft/annum:</td>
<td></td>
<td>£400,000</td>
</tr>
<tr>
<td>Hence <strong>annual profit ratio</strong> is only</td>
<td></td>
<td>5%</td>
</tr>
</tbody>
</table>
Overseas earnings

In Tables 4 and 5 column 10 shows the overseas funds that would be earned by the two respective products (these two being mutually exclusive). Summarising the outlook in perpetuity from year 41 onwards, we have the following potential earnings:

<table>
<thead>
<tr>
<th>Alternative (a): 19,000 tons U/B pulp</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>20 million bd. ft sawn wood</td>
<td>855,000</td>
</tr>
<tr>
<td></td>
<td>765,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,620,000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternative (b): 19,000 tons Kraft sack</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>20 million bd. ft sawn wood</td>
<td>1,750,000</td>
</tr>
<tr>
<td></td>
<td>765,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2,515,000</strong></td>
</tr>
</tbody>
</table>

The best estimate of overseas earning potential on a long-term basis is probably 50/50 pulp and paper - giving a prospective total annual earnings of £2,067,000. It is questionable whether the high income from Kraft sack paper could be maintained indefinitely, so the 50/50 product mix provides a conservative basis for estimating overseas earnings.

<table>
<thead>
<tr>
<th>Forest ride value</th>
<th>F.o.b. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>£452,000</td>
<td>£2,067,000</td>
</tr>
</tbody>
</table>

**Footnote:**
All data for both agriculture and forestry were based on prices recorded for 1962/63 and are accordingly expressed in £.s.d.
### SUMMARY COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>Agriculture</th>
<th>Forestry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm gate and forest ride values</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual gross output</td>
<td>£632,000</td>
<td>£452,000</td>
</tr>
<tr>
<td>Annual net output</td>
<td>£194,000</td>
<td>£333,000</td>
</tr>
<tr>
<td>Land expectation value</td>
<td>£9</td>
<td>£17</td>
</tr>
<tr>
<td>Internal rate of return</td>
<td>52%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>F.o.b. values</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual overseas earnings</td>
<td>£755,400</td>
<td>£2,067,000</td>
</tr>
</tbody>
</table>

This analysis has taken the earlier study one stage further by converting the value of physical output at farm gate or forest ride into overseas earnings. It illustrates the much greater significance of value added by processing forestry products than by processing farm products. The rates of export earning to forest ride value is 4.6:1 for forestry compared with an export earning to farm gate value of 1.2:1 for agriculture.

A definitive study should, of course, include an estimate of the profitability as well as the extent of processing. It should also take into account any import content in domestic costs. I discussed this point at some length in an earlier publication, where I suggested that a cost-benefit analysis should make allowance for the over-valuation of the $N.Z. by incorporating a premium for overseas exchange into the evaluation criterion. Time does not permit me to repeat this argument here, but it is a point that might perhaps be discussed during the course of the Conference.

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A REVIEW OF EVALUATION STUDIES IN NEW ZEALAND

AGRICULTURE AND FORESTRY

R. W. W. Johnson
Lincoln College

In this paper I have set out the main developments in project evaluation in agriculture and forestry in New Zealand. To some the treatment may seem rather brief. I have endeavoured to assemble a bibliography of the appropriate reports and the following discussion relates to the reports quoted. I have probably missed some of the reports prepared (especially those done by Government Departments) and I have tended to discuss several reports together if their method of treatment is essentially similar. It should be noted that some reports quoted are in manuscript (MS) or mimeograph (Mim.) and may not be in general circulation. Finally, I apologise for any errors of omission or fact in advance to the authors concerned.

To facilitate discussion, the subject is divided into five different types of project; irrigation schemes, water supply schemes, drainage schemes, individual farm intensification schemes, and land development schemes. Some schemes are difficult to classify, as for example comparisons of farm forestry with pastoral farming, but in the main the above five categories cover the literature and the bibliography is arranged accordingly.

Considering the long history of project evaluation in the United States, its very recent application in New Zealand merits comment. It would appear that the allocation of capital in the public sector has been decided for many years by rules-of-thumb by local and political pressures rather than by objective economic tests. It could be that economic criteria have not been considered in the public decision making area, or it could be that such rules-of-thumb have been sufficiently indicative of the economic prospects of a scheme to know when to proceed.

Uncertainty introduced by fluctuating prices may outweigh precise tests of profitability. Schemes launched into a period of prosperity will tend to be regarded as successful, and those launched just before or into a period of adversity will tend to be written off. There is little that prior evaluation can do to overcome these problems.
The real question is whether the set of techniques known as project evaluation are better than rule-of-thumb methods. To be sure of this, we need the co-operation of administrators as well as field investigators. We need to formulate the set of rules as precisely as possible, and we need an assurance from the policy-makers that the results would be adopted in policy situations.

Since the subject of this paper includes both agriculture and forestry, it is appropriate to note that forest economists have incorporated discounting techniques in their analyses for many years. I understand, however, that the assembly of the relevant data and building up of projections for 40 years or more is regarded as a laborious task in forest circles and is not carried out as a routine assignment for every new forest planting. In Canterbury, for example, recent plantings are related to expected demand, and I assume that the planners expect future timber prices to recompense them for their efforts. Comparisons of agriculture and forestry are discussed later.

Finally, in these introductory remarks, I believe it is important to distinguish between the funding of investment in the public and private sectors. In the private sector, we assume that individuals and companies employ precise investment criteria, or have satisfactory rules-of-thumb which do the job for them. Secondly, there are certain institutions, private and public, which provide the finance for these investments. Banks and the State Advances Corporation are examples here. They assess the worthwhileness of the individual situation by their own rules and finance it if they see fit. Thirdly, there is the area of public investment which varies from the activities of municipalities, to flood control, land development, irrigation schemes, public health, and so on. These schemes or expenditures are not necessarily uneconomic; they may be too large for individuals, they may require co-operation over boundaries in the private domain, they may only be economic if run in large units. We must realise that the perfect allocation of funds cannot be achieved between each government department, between the private and the public sector, and often even between projects under a single department's control.

In general, the rules of project evaluation can be applied in both the private and public sectors. Only certain minor adjustments are required in terminology and approach. But the world being an imperfect place, with many social objectives incapable of precise measurement, the perfect allocation of funds will never quite be achieved.

The application of project evaluation in agriculture and forestry in New Zealand was first undertaken by Professor J. T. Ward. His first paper setting out the principles of land use evaluation for forestry and agriculture is dated December 1961 (41). Before this, it appears that the conditions were right for take-off (if you will pardon the metaphor). M.R. Woods points out in a paper on
the economic appraisal of community land betterment projects (22) that in 1955 District Commissioners of Works were required to obtain a report from the Department of Agriculture on all rural water supply schemes, and that in the same year the first economic report on an irrigation scheme appeared (1). Later in 1960, economic reports on all irrigation schemes were also made mandatory. Woods' paper is dated February 1963, and although written some time after Ward's pioneer paper, makes only passing reference to modern project evaluation as we now understand it. We also have a paper written by the classifier to the North Canterbury Catchment Board, A.C. Norton, dated December 1960 (23) which defines costs and benefits in terms closely anticipating recent usage, and which questioned simple annual comparisons of costs and benefits:

"The problem to me is (a) do we consider the net benefit as a dividend on money invested (i.e. cost) which should return say 5 per cent, or (b) do we consider that the annual net benefit should equal the annual interest, capital repayments and maintenance charges for the estimated life of the work done, e.g. 25 years for building stop banks, 100 years for tussock grassland improvement and tree planting, or (c) do we consider the scheme economic from the individual or national or both points of view?" (23, p.4+)

I now turn to the individual types of project and discuss the development of the form of analysis in each in turn. It is appropriate to commence with irrigation schemes because these exhibit most of the difficulties encountered and are worth discussing in detail. The other schemes are discussed in the order shown in the bibliography.

I start with the 1961 report on the Maniototo Irrigation Scheme (4). As one of the report's authors describes it (22) this was the first time scheme costs and farmers' development costs were added together to find the total investment required to produce a given number of additional stock units. The result was an estimated cost of £79 per stock unit added by the scheme, and since the then accepted on-farm investment per stock unit was £15-20, the scheme could not be recommended. In a second report (5), the authors estimated the annual costs associated with the scheme (including interest and a maintenance and renewal fund) and determined the residual income available to meet these annual fixed costs on a stock unit basis. They found 152,000 stock units would be required to meet annual fixed costs, whereas 38,000 units were all that the scheme could support.

One feature of the proposed scheme was that the irrigation water would be held in a dam in an area already partially developed. The authors correctly debited the loss in carrying capacity in this area to the scheme as a whole.
In these reports, the 'without irrigation' situation is analysed in terms of dryland potential, i.e. what would have happened in the course of time without additional water. This concept proved difficult to substantiate when the report was discussed at inter-departmental level. Comparisons were made between present carrying capacity and readily attainable irrigation potential. Clearly, comparisons must be made on the basis of readily attainable potential, or on present carrying capacities of both methods. It should be remembered that farm management potential changes fairly slowly, and proponents of schemes tend to assume rather optimistic coefficients when it is in their interests to do so.

The Maniototo scheme was re-assessed again in 1966 (6). By this time the readily attainable potential of the plain under irrigation has risen from 165,000 ewe equivalents to 206,000 ewe equivalents. The potential of the area as dryland was fixed at 100,000 ewe equivalents. After adjustments, the stock increase due to the scheme was raised from 38,000 ewe equivalents to 86,600 ewe equivalents. (Part of this increase is explained by a pumping extension which had later been added to the original scheme.)

The author then analysed the project according to the rules of project evaluation. These included defining the sequence of scheme and farm expenditures and of resulting increases in net farm income; choosing a discount rate; capitalising the post-development income; and different residual incomes per ewe equivalent according to variations in product prices received. The analysis is set out as follows:

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Costs</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pessimistic</td>
<td>V₁</td>
<td>C₁</td>
</tr>
<tr>
<td>Realistic</td>
<td>V₂</td>
<td>C₂</td>
</tr>
<tr>
<td>Optimistic</td>
<td>V₃</td>
<td>C₃</td>
</tr>
</tbody>
</table>

V₁, V₂, V₃, and C₁, C₂, C₃, are the present worths of the respective time streams of project benefits and costs. As might be expected, V₂ = C₂ is highly negative, and the benefit-cost ratio varied from 0.18 to 0.23. The fundamentally uneconomic nature of the scheme was not greatly altered as the 1962 report had arrived at a break-even ratio of 0.25 without sophisticated analysis, (i.e. 37,900 ewe equivalents were 25 per cent of the 152,000 ewe equivalents estimated as desirable).

Several more reports have been prepared along the same lines (7, 8, 9) and the evaluation procedures are similar. Attention is drawn

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* I am indebted to Mr H.J. Plunkett for this point.
to the fact that the evaluations are carried out to ascertain the
national point of view and that an individual's situation needs to
be budgeted separately. Care is required in assessing dryland and
irrigation 'potential'. It is suggested that the present most
efficient farmers should be compared with a group of top irrigation
farmers. The use of market gardening intensification is mentioned (7)
and the limits of benefits in this area examined. The problem of
incorporating an existing scheme which becomes redundant is analysed (8).
While attempts have been made to make these reports as clear as
possible, especially with regard to discounting procedures, some
more improvements in presentation of basic data appear desirable.

We turn now to rural water supply schemes under the aegis
of the Department of Agriculture. Earlier reports which have come
to my notice simply assess the increase in carrying capacity that
would result from the new supply, place an annual value on it, and
compare this with the annual costs of financing the scheme (10,11).
Capital costs are converted to annual charges, by a sinking fund
factor. The local instructor in agriculture makes the assessment
of increased carrying capacity. If benefits exceed costs, a
subsidy of one in two is recommended.

In 1964, project evaluation techniques appear for the
first time (12). The procedures follow those used for irrigation
projects (6). Scheme costs are identified according to the year
in which they are undertaken, and extra livestock increases are
assumed to have an opportunity-cost. Fencing is assumed to be
necessary as well as on-farm reticulation and watering points. Annual
running costs are capitalised into perpetuity. The increase in
carrying capacity is spread linearly over the number of years it is
calculated to complete the scheme, and the post development benefit
is capitalised in perpetuity. The social present worth, or V-C, is
then calculated, and usually a break-even rate of interest as well
(the internal rate of return).

In general, the reports actually sighted all show favourable
results (12, 13, 14, 16). Break-even rates of interest varied from
10 to 15 per cent. It appears that rural water supply constitutes
a restriction or bottleneck on carrying capacity, and that communal
pumping schemes can be provided at a cost well within the value of
assessed benefits that would result. Farmers must provide some
voluntary labour, provide a fixed capital sum toward the cost, and
pay an annual charge based on off-take points.

The assessment of benefits appears over-simple. It is not
always clear if the effect of improved water supply alone is being
considered. Some reports include top-dressing as on-farm charges.
It is not clear whether this is complementary, i.e. a joint development
cost, or development which will take place anyway. There is some
confusion on the valuation of benefits. Early reports use the
residual farm income concept used in the irrigation reports; later
water supply reports use a much higher gross margin per ewe equivalent. Needless to say, these assumptions have an important bearing on the results of the analysis, and need clarification.

Finally, the arguments for subsidies in the recommendations set forward in these reports appear most naive. I quote, "If the criterion for justification of a subsidy on a rural water supply scheme is that the community as a whole should benefit from the Public Funds so invested, then it is our recommendation in light of the increase expected and the results shown in the appendix, that this scheme qualify for a subsidy at the usual rate of £1 for every £2 expended." (12). I find it difficult to believe that a scheme with an internal rate of return of 15 per cent requires a subsidy! The subject of project evaluation and subsidies is referred to again later.

I now turn to drainage schemes. We use examples from the North Canterbury Catchment Board. The examples are drawn from the work of Mr A.C. Norton. We first look at a scheme analysed by means of annual costs and benefits (24). The analysis was carried out for an area including part or all of 14 properties, and was concerned with farm development costs and not scheme costs directly. At the end of 10 years, gross income was estimated to increase by £33,084 and gross expenditure increase by £29,304. (Expenditure includes interest on repayment of on-farm development costs, assuming 6 per cent for 25 years.) It is assumed that this 10 year level is representative of the whole 25 year period. Thus total extra income generated is £3,780 x 25 or £94,500. Maintenance of capital works at £1,700 per year comes to £42,500. Interest on maintenance expenditure is £2,711 and other charges come to £2,006, leaving £47,283 as an estimate of the capital cost which would be justified in constructing the scheme.

This approach seems to me to get very near the answer that a discounting analysis would give. The one difficulty is the even spreading of benefits over the whole period of amortisation. The shape of the production increase in time might be such that late development would depress the present worth of total extra benefits. The annual equivalent of this present worth might thus be lower than £3,780. The report does not state the estimated cost of the engineering aspects of the scheme.

Subsequent reports from the same office incorporate discounting into the same approach to scheme costs (25, 26). Increases in net farm income and farm capital expenditure are allocated to the years in which they take place, and then constant net income is assumed for the remainder of a period of 40 years. These streams are discounted to present values at 6 per cent, to give farm present worth (V - C) of the scheme. From this present worth, if positive, the discounted value of scheme maintenance expenditure for 40 years is deducted, to give an estimate of the justified capital cost of the works proposed.
The author emphasises that the reports are drawn up from the national viewpoint and that it would be necessary to consider taxation and the need for incentive in the individual viewpoint.

At this point I want to digress for a moment to consider a retrospective evaluation from this same source (27, 28). The author was attempting to follow up a drainage scheme carried out in 1946/47, eighteen years later. Considerable difficulty was experienced in finding 1946/47 levels of productivity, but once this was overcome, estimates of increased farm income and expenditure could be derived as a lump sum difference. Construction and maintenance costs were known. The author converts all prices to a 1965 base and then by appropriate assumptions determines the time pattern of investment and income. The key time problem, the pattern of income increase, is assumed to be a simple linear cumulative series. The present worth of the improvement programme over 18 years is not quoted, nor is any time preference rate, but the results are presented in internal rate of return form. This turned out to be 12 per cent over the eighteen year period.

The Agricultural Economics Research Unit at Lincoln College is undertaking a further study along these lines. Fortunately a pre-construction evaluation was made of the particular scheme concerned, though I believe this is going to be of limited usefulness. The price problem is of concern, and the selection of the right price indices could be difficult. Further, the assessment of the appropriate levels of technical performance in the absence of the scheme poses the usual problems. Mr Plunkett will be speaking to the seminar on these problems.

I now come to farm investment studies using discounting techniques. Again the pioneer work in this field is that of Professor Ward. In his 1961 paper (41) he correctly observes that a productive valuation budget provides the criterion for land use decisions. Applied to farm intensification or development situations, the status quo budget now provides the starting point for every paper in the bibliography. Once the development period is complete, a further status quo budget provides a terminal benefit for capitalisation or other manipulation. The principles of investment analysis were taught by Ward at Lincoln for a number of years and are set out in (46). Gow (30) and Holden (31) also set out the main essentials of the technique, and it is used and developed by McArthur (33) and then Frengley, Tonkin and Johnson (35). In fact, the latter report, published in 1966, is based on earlier work of Dr Ward's.

There is some confusion in the nomenclature of development. Ward (46) heads up a section 'marginal relationships' when he is in fact referring to additional cash flows due to development. He works out the 'marginal return on capital' as the percentage return on additional capital. This tends to be misleading. The true marginal return on capital through time can only be obtained from a properly specified development hypothesis that includes optimisation procedures. This work has yet to be done.
Farm investment studies should be divided into the retrospective, usually based on analysis of farm accounts (29, 30, 31, 32, 34, 36), and the forward-looking, based on forward budget methods (35, 37, 38, 39, 40). The historical, or ex post studies, involve problems of price changes which cannot fully be accounted for. It is difficult to give meaning to a statement such as: "What is the profitability of development at today's prices, if a historic programme of development were repeated over again?" I now incline to the view that these ex post studies should be made in actual prices, because all operational decisions were made with prices as they stood at the time. There may be some argument for correcting for 1950 wool prices, but then we eliminate the very source of capital that enabled many farmers to take off.

The forward, or ex ante, studies avoid the price problem by assuming that current prices are the correct ones, or at least some combination of past and present prices is correct. The parametisation of prices is essential in ex ante studies. For a recent survey in Taranaki I have had to completely re-work the results as prices have changed. A recent study of development in Southland makes three different price assumptions based on present prices continuing, average price relationships of the past being repeated, and a price squeeze situation developing (39).

Most of the studies capitalise net income at the post development stage; only Gow has explored sale prices of land as a substitute for this procedure (30). There appears to be no equivalent of the salvage values of engineering economics in farm investment analysis. The analysis of forward budgets by computer methods is a more recent innovation in this field (37).

The studies of farm investment programmes have lead to considerable research in the processes of development. Some surprising results which have appeared in the past can be better understood by these methods. For example, Taylor found that farm development programmes that take different periods to reach the same target income gave conflicting tests of profitability (38). The fast programme was not always the most profitable. Mr McArthur and Mr Jensen will be addressing the seminar on some of these problems.

A minor controversy has sprung up over the use of certain criteria in farm investment analysis. One school maintains that the present worth of a development programme is suitable for between-farm comparisons. The opposing view is that between-farm comparisons must be based on a V/C type of ratio. An example of the use of one such ratio is set out in a recent publication (34).

All farm investment studies include the individual point of view. It is common to include taxation in the analysis. It is not clear how to measure the incentive effect of a development programme. Some authors recommend that farmers be shown the profile
of net additional returns and that the sacrifices and gains be stressed (39). It seems that present worth measures are not particularly useful in addressing farm audiences. More use of these techniques by farm advisers may well give a guide to the future handling of these problems.

The principles of project evaluation for forestry have been well set out by Professor Ward (41). In general, the sequence of costs and returns typical of forest establishment and utilisation can be brought back to present worths at appropriate interest rates. If this present worth is positive, then it can be expressed on a per acre basis, known as the land expectation value. Ward provides a good clear example of the working to arrive at this value through budgeting (41). The same result can be obtained by applying the Faustmann formula, which specifies standing values, values of thinnings and so on in a correct compounding equation. The formula assumes that a forest rotation is followed in perpetuity, and is equivalent to the analysis of farm development with post-development income capitalised in perpetuity. It should be noted that the budgeted land expectation value referred to by Ward is for a single rotation only and thus slightly underestimates the land expectation value in perpetuity.

The land expectation value type of analysis has been used by Chisholm in a study of the relative profitability of forestry and agriculture on the lower producing soil classes of the Manawatu-Rangitikei sand country (42). He emphasises the difficulty of estimating physical input output relationships which will be representative of the actual production achieved over the next 50 years. Secondly, there are the errors arising from inaccuracies in predicting resource costs and product prices 50 years ahead. Thirdly, his results proved to be extremely sensitive to the external interest rate assumed. In the light of the above data limitations, the author considers that no differences in land expectation values of less than £10 per acre should be treated as significant. The general trend of the results showed that large scale forestry was significantly more profitable than sheep-beef farming, that the profitability of large scale forestry and dairy farming was of the same order of magnitude and that dairy farming combined with forestry was more profitable than either enterprise on its own.

The final report in this series is a study of the development of the Maraetai block by Ward and Parkes (43). The principles of project evaluation are those already set out by Ward (41, 46). The concept of the demand price and the supply price is utilised; but does not, in my opinion, add to the clarity of the presentation. Features of the analysis are the treatment of "social" costs (roading and housing) inherent in the settlement pattern, but in the case of roads, benefiting others beside the settlers; the introduction of pessimistic, moderate and optimistic price assumptions; the projection of large scale farming on a permanent basis, and the comparison of forestry with agricultural land use. The level of detail in the analysis is most impressive and presented very coherently. The final results of the analysis show
little difference in the relative profitability of forestry and agriculture. Table 12:2 (43, p.136) is illustrative of this.

<table>
<thead>
<tr>
<th></th>
<th>Excluding social costs</th>
<th>Including social costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agr.</td>
<td>For.</td>
</tr>
<tr>
<td>Future net worth (£000)</td>
<td>3049</td>
<td>4593</td>
</tr>
<tr>
<td>Present net worth (£000)</td>
<td>706</td>
<td>652</td>
</tr>
<tr>
<td>Land expectation value (£)</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Internal rate of return (%)</td>
<td>7</td>
<td>6%</td>
</tr>
</tbody>
</table>

Finally in this survey of project evaluation in New Zealand, I return to the subject of subsidies. I have already remarked on the need for a clearer statement on the granting of subsidies for water supply schemes. Parkes has drawn attention to the proper criteria in these cases (48). He points out that national viewpoint analyses of water supply schemes merely justify going ahead with a scheme. The justification for the subsidy payment should be based on the divergence between national net benefit and private net benefit. A subsidy should be used to raise the private net benefit to a level that is worthwhile to the individual. It is not justified if the net private benefit is already adequate, unless further incentives are needed.

In an early reference in this paper, Woods draws attention to the subsidy element in water charges for irrigation schemes (22). “The question at issue is whether the water rate should be set after taking into account what farmers could or should be expected to be able to pay or whether the charge should be in direct relation to the cost of the scheme, the proposal being accepted or rejected by the property owners on that basis. Needless to say, in a world that has become more urbane and more systematised, no consideration is now given to what farmers should be able to pay for their water. By act of Parliament, the rate struck is required to cover annual capital charges on one quarter of the total cost of the scheme, in addition to all running and maintenance costs” (22, p.3). This paragraph strikes me as truly amazing, and suggests that pressure groups are urbane and systematised.

Certain land retirement schemes in this country are also eligible for subsidies. I understand these also qualify on the basis of national benefits. Mr Frengley of the Farm Management Department at Lincoln College is investigating the basis of retirement subsidies and the seminar may be hearing from him on this subject. In all the cases outlined above there is clearly a need to scrutinise the legislation itself, as well as applying the rules in different types of case study.
This concludes my review. The papers and reports referred to in the text are attached in the accompanying bibliography. We have made progress in New Zealand in all five types of project discussed. The application of the techniques described is remarkably uniform and discrepancies are mostly concerned with the treatment of data. It is apparent that a number of practitioners are working in isolation and that a national seminar would help to standardise procedures and uses of data. I suggest that the framework provided by project evaluation analysis does help to set problems in their proper perspective and one of its contributions is that it forces us to ask the right questions. It is not clear, however, how useful project evaluation can be to policy makers. More information is needed on this point.
1. Department of Agriculture

(a) Irrigation Schemes


(3) E.J. Stonyer and N.R. Woods: Report on the Irrigation Scheme Supplied from the Frazer River Catchment Area (Mim.) 1958 (approx.).


(7) "Waiareka Valley Irrigation" (Mim.) Feb. 1967.


(b) Rural Water Supply Schemes


(20) Department of Agriculture (Christchurch Office): Te Moana Water Supply Scheme - South Cant. (not sighted), 1966.


(c) General


2. Catchment Board Studies


3. Farm Investment Studies


48.

(40) R.A. Bonifant et al. The Economics of Pakihi Development in the Westport Area, Agricultural Economics Research Unit Publication (forthcoming).

4. Forestry Studies


5. General


INTRODUCTION

Project evaluation has assumed a position of increasing importance in recent years. As a technique of applied economics, it has been accepted by engineers, town planners, soil conservators, farm management specialists, operations research workers and accountants as well as economists working in several different fields. As an operational technique, project evaluation has been enhanced by contributions from several professions and has developed from a mere discounting exercise to one of the established and accepted professional tools of trade.

Large scale projects involving funds from the public sector, or international lending institutions, are quite commonly submitted to economic evaluation. In an increasing number of countries a favourable report from economists is required before a project is accepted. At the farm development level, both the economist and the farm management specialist have found the techniques of project evaluation increasingly useful in assessing the economic desirability of development.

The term "project" should be interpreted in its widest sense, referring in large scale projects to perhaps a reservoir or series of reservoirs and power-generating stations, or at the farm level to the process of farm development, use of machinery, etc., or to any course of action between these extremes. The terms "project evaluation" and "investment evaluation" are therefore usually accepted as synonymous. They suggest the use of discounting procedures to account for the passage of time. This symposium will be restricted to these procedures and will not consider other techniques.

The discipline of economics has the disadvantage that many of the terms used do not have a unique definition. Many of the terms in common use have a variety of meanings; this

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I am indebted to Mr R.W.M. Johnson, Mr W.F. Musgrave, Mr B.J. Ross, Mr H.J. Plunkett & Mr A.T.G. McArthur for their helpful comments and suggestions during the preparation of this paper.

1 The term "development" is ambiguous. It is used both in a "land development" context, referring to the subdivision of larger holdings for closer settlement, and in a "farm development" context referring to the intensification of operations within the farm.
lack of precision and uniformity in the use of common terms has been responsible for some confusion and misunderstanding of economic studies, and their interpretation.

Earlier contributions to the field of the evaluation of large-scale projects have suggested terminology and procedures for project evaluation (4,8). Recommendations for nation-wide adoption were incorporated in the two editions of the "green book" (12) of 1950 and 1958, which dealt with river basin planning in the United States. More recently the President's Water Resources Council (PWRC) has prepared (10) a statement of definitions, standards, procedures for guidance in the large-scale project evaluation. To my knowledge no parallel statement exists for evaluation of investment in farm development.

Slight changes have occurred from time to time in the terms used in project evaluation. This paper draws on the most recent publications, and suggests an appropriate terminology to use in New Zealand project evaluation. Every advantage is to be gained by accepting existing terminology, with modifications which may suit the special aspects of the New Zealand scene. This paper is not intended as a dictionary of terms in use; these often vary with the individual, which makes comparative study difficult.

**Viewpoint of a Project**

The benefits and costs accruing from the establishment of a project will not be distributed equally among the individuals of an area, nor will they affect the various sectors, regions and industries in the same way. It is quite conceivable for example, that a project which is highly desirable when the interests of the nation are considered, will adversely affect individuals or groups in the area in which it is established. It is necessary therefore to decide which interests are being considered in any project evaluation, and to specify these interests by stating the viewpoint from which the project is evaluated. For any project there may be several viewpoints:

(a) **Comprehensive Public (or National) viewpoint** - defined by P.W.R.C. as effects on "all persons and groups within the zone of influence of a project". The effects of project establishment should be traced as far as possible throughout the economy, and will include benefits and costs accruing to the nation as a whole. These are usually evaluated through effects on national income, on the somewhat dubious assumption that national income can be identified as national welfare. Marglin suggests national efficiency as a more acceptable goal. In the case of projects which involve overseas sales and purchases the national viewpoint should include consideration of the net requirement of the project for overseas exchange.

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2 Ch. 2 in (6).
(b) **Political-Administrative viewpoint** - the ultimate effect on the political administration of the establishment of a project. It is difficult to assess the role of political factors in the justification of projects; it is probably justifiable to assume that some projects receive higher priority if political ends are achieved. Trade and tariff policy, the level of government expenditure, government borrowing policy, the level of employment, and probably national prestige, all with political significance, may be affected.

(c) **Regional or Local viewpoints** - the effects on surrounding entities such as specific regions, local populations, and local governments. The establishment of a project within a region could increase the local population, and the income earned, but add heavy burdens on local governments in road construction etc. Some effects which are benefits from one viewpoint will be costs from another e.g. the provision of a rail service to an area would be a benefit from the local viewpoint, but involves a cost from the national viewpoint.

(d) **Industry viewpoint** - the effect on an industry, through both pricing and production, of the establishment of a project designed to improve efficiency. Some sections of the industry may not be able to receive the benefits of the project, possibly through remoteness, and may have to be relocated.

(e) **Individual viewpoint** - the effect of a project on an individual business, its operation and profits. Farm development studies are often confined to this viewpoint, and do not consider project effects outside the farm boundary.

The specification of the viewpoint from which a project is to be studied should be accompanied by a statement detailing the primary aim of the evaluation; e.g. it is important to distinguish whether the object of the evaluation is

(a) to provide information for an accept-reject decision on a given project, which is assumed not to be competing with other projects for investment capital, or

(b) to give the project a comparative rating with other projects which are competing for investment capital.

**Capital and Investment**

It is not the purpose of this paper to discuss the semantic differences of the meaning of "capital" and "investment" to the various professions. Comment will be restricted to the meaning of the terms as understood by economists; the accountant, investor or banker should have little difficulty in reconciling the use of these terms with their professional jargon. The terms do not refer specifically to sums of money, or to the use of money in purchasing shares etc., but to "real" assets such as the raw materials of production, machinery, buildings and so on. In the agricultural sector these
would normally be taken to include land, livestock, farm machinery, irrigation equipment, improved soil fertility, pastures, fencing, drainage, and other assets of a permanent or lasting nature which, provided they are maintained satisfactorily, may be used to increase production and income.

Capital refers to the stock of these assets, or inputs which have been previously produced by the farm, or by another producer. It will be recognised that capital, in the economic sense, will normally include the Fixed Assets and most of the non-negotiable Current Assets of the normal balance sheet. For convenience, capital and investment are usually expressed in money terms.

Investment is the process of acquiring, or of producing capital, the process of committing resources in the accretion of capital. It includes the sacrifice of an immediate and certain return from cash or capital, hoping to receive benefits in the future.

Gross Investment or the total commitment of resources could be: \( I_t, I_t+1 \)

(a) Reinvestment - the purchase of equipment as replacement due to wear and tear, or obsolescence;
(b) Expansion outlay - to increase the output of an enterprise.
(c) Modernization outlays - designed largely to reduce costs (may coincide with (a)).
(d) Strategic investment - where the return of the investment might be indirect e.g. "defensive" investment to protect against adverse conditions or risks, and "offensive" investments to improve the relative technical or economic conditions of the investor.

Net Investment or merely investment represents the difference between the capital stock in two successive time periods, e.g.

\[ I_t = K_t - K_{t-1} \]

(when \( I \) refers to Investment, and \( K \) refers to capital)

It is important at this stage to distinguish between an investment decision and a financing decision. Traditionally the investment decision indicates what specific assets should be acquired, and the volume of funds to be committed; the financing decision indicates the source of the funds.
The distinctive feature of capital as an input in any production process is that its contribution to production is usually made over more than one year, e.g. irrigation equipment is normally expected to be in use for several years. Time is therefore an essential element of the use of capital. The measurement of the amount of capital employed in any productive process may not be shown satisfactorily by a single figure representing money value, but should also include an estimate of the time period involved, e.g. the use of a $2000 2-man machine for 10 years. There are two ways in which the use of capital can be increased - capital widening, an increase in the total stock of capital without change in capital intensity, e.g. the use of two $2000 2-man machines and capital deepening, an increase in the total stock of capital to allow more intensive use of capital relative to labour for a given volume of output e.g. the use of a one-man machine.

Investments have also been classified (5) according to the relationship between the time a project is initiated and the time its product is available for consumption. Three cases are usually considered;

(a) **Point-Input, Point-Output** - Investment outlay is concentrated in a single period of time and the product is available for consumption within a single time period.

(b) **Continuous-Input, Point-Output** - Investment outlay is spread over a period of years, while the product becomes available for consumption within a single time period.

(c) **Point-Input, Continuous-Output** - Investment outlay is concentrated within a single period of time, but the return from the investment becomes available over a period of years. Most investments in the agricultural sector fall into this category.

A fourth category could well be considered for the special case of investment in farm development - the **Continuous-Input, Continuous-Output**, case. In this case capital investment is applied in several distinct forms, e.g. pasture improvement, livestock machinery and so on. While many inputs in farm development may clearly be applied in a single time period, others such as livestock and pastures may be regarded as self-generating and capable of improvement to a higher productive capacity with the passage of time. Further, management and biological factors could well dictate an ordered sequence of investment over several time periods.
Investment studies in the agricultural sector which allow for the continuous application of inputs involve particularly difficult problems because of the inadequacy of technical information concerning production response, and the most desirable combination and sequence of inputs. In the absence of this information the skill of the individual undertaking the study, and the standard of technical knowledge, will determine the ultimate value of the conclusions.

Frequently sub-optimal investment decisions are taken because the borrower is unable or unwilling to invest on a scale which will earn the optimum return. This situation is termed capital rationing and has been shown to occur in two ways:

(a) internal capital rationing - an unwillingness to invest arising from within the firm (farm). This could be due to the desire to maintain a high liquidity position, a reluctance to borrow, or a psychological discount of returns due to risk and uncertainty. Technically these mean that the individual's discount rate is higher than that of the community.

(b) external capital rationing - financial institutions may be unable or unwilling to provide funds to the investor.

In the first case the restraint on investment derives from within the firm; in the second case a restraint is imposed on the firm from external sources. The result in either case is similar - funds may not be invested to obtain a return approaching the optimum.

Large-Scale Projects

Benefits are defined as the increases or gains in the value of goods and services which result from conditions with the project, as compared to conditions without the project. Benefits should be measured net of associated or induced costs, and include both tangible and intangible benefits. They may be classed as primary or secondary.

Tangible Benefits - those which can be expressed in money terms, preferably based on actual or simulated market prices for the products or services of the project. If these measures are not available, the cost of the most likely alternative means to provide the equivalent products or services may be used as a measure of the minimum value of such benefits to the users.

3 The sections on definition of Benefits and Costs are taken largely from (10).
Intangible Benefits - those which are not fully measurable in money terms, or may not be satisfactorily expressed in money terms, in formal analysis. The significance of intangible benefits should be based on "informed judgement".

Primary (or Direct) Benefits - the value of goods and services directly resulting from the project less associated costs incurred in realisation of the benefits and any induced costs not included in project costs. Primary Benefits included in the study of water resources projects could derive from:

(a) Water supply for:
   (i) domestic use
   (ii) municipal use
   and (iii) industrial use,
   the improvement in quantity, dependability, and convenience of use.

(b) Irrigation - increase in the net income of agricultural production attributable to irrigation only;

(c) water quality - the contribution to public health, safety, economy and efficiency in use which are attributable to changes in water quality;

(d) navigation;

(e) electric power;

(f) flood control and prevention;

(g) land stabilization;

(h) drainage;

(i) recreational uses;

(j) fish and wildlife;

(k) other benefits - such as area re-development, national defence etc.

Secondary (or Indirect) Benefits - the increase in the value of goods and services which indirectly result from the project under the conditions expected to occur with the project as compared to those without the project. Secondary benefits are measured net of any economic non-project costs which have to be incurred to realise them. The term would normally be
applied to the increased net incomes of the various businesses from farming, wholesalers, retailers, processing, and service industries which stem from a project.\(^4\) Care should be taken to eliminate the purely transfer items, and include only the value of the increment in output from an investment.\(^{11}\)

**Costs**

**Project Economic Costs (or Direct Costs)** - includes the value of goods and services used in constructing, operating and maintaining the project. This category of costs includes interest during construction, all other identifiable expenses, losses, liabilities and indirect adverse effects connected with the project whether or not compensation is involved, whether tangible or intangible. Project economic costs are the sum of:

(a) installation costs - the value of goods and services necessary for establishment of the project - such as investigation, design and planning, purchase of land, rights, relocation of facilities, and project construction;

(b) operation, maintenance and replacement costs - the value of goods and services needed to operate an established project and to maintain the project in a sound operating condition during its economic life;

(c) induced costs - all uncompensated adverse effects caused by construction and operation of a project, whether tangible or intangible. This category may include the increased cost of government services and net uncompensated adverse effects on the economy such as increased transportation or telephone services. (Indirect costs may be added to project economic costs or deducted from primary benefits).

Project economic costs associated with an irrigation project would indicate the cost of supplying irrigation water at the farm gate.

**Associated Costs (or Indirect Costs)** - the value of goods and services over and above those included in project costs needed to make the immediate products or services of the project available for use or sale. In the example of an irrigation project, this would include costs to the farmer of taking water from the farm gate to the point of application, i.e. "on farm" costs. Associated costs are deducted in the calculation of primary benefits.

\(^4\) See (8) Ch. 9.
Taxes Allowances in lieu of taxes or taxes foregone should not normally be included in project economic costs. These are a re-allocation of funds within the community and not a cost incurred for the creation of value.

SPILLOVER EFFECTS are defined as the uncompensated effects on the costs and receipts of a firm or group of firms caused by any particular change in economic activity. The term embraces all types of external effects from a project, whether they are economies or diseconomies. Spillovers may be:

(a) Technological - affecting the technical efficiency of other producers - e.g. the addition of a project using water upstream could enhance the output of power plants and irrigation schemes downstream. Air and water pollution may have a social cost which should be considered as a spillover effect.

(b) pecuniary spillovers, associated with shifts in prices. e.g. the establishment of a project could:

(i) increase demand for some factors of production and increase its prices to all purchasers of the factor,
(ii) decrease the price of substitute products,
(iii) increase the price of complementary products,
(iv) decrease the price of the output of the project.

Pecuniary spillovers are usually not considered in large scale project evaluation since the gain to one firm or group of firms would be offset by losses to other firms; if the project is desirable the re-adjustment in prices and outputs may be desirable. In some cases, e.g. large indivisibilities in investment, it may be wise to consider these effects.

"Multiplier" effects although seldom considered in project evaluation could contribute significant spillovers. Consideration of multiplier effects would be desirable if the evaluation confronting the decision maker is either the establishment of a particular project, with no alternatives, or if alternatives exist, the comparison of projects whose multiplier effects are expected to be dissimilar. In fact the same remarks could apply to other spillover, and secondary benefits.

5 Spillover effects are discussed in (8) Ch. 8.
The fine line of distinction between secondary benefits and spillover effects as externalities is drawn by some authorities only. McKean (8) suggests that secondary benefits are those accruing to businesses locally associated with a project, and that spillover effects are those which accrue beyond this "first line" of association. This can be interpreted to mean either outside the area in which the project is established, or beyond the immediate impact of secondary benefits, such as increased incomes of businesses associated with the project. The P.W.R.C. makes no such distinction and implies their inclusion in secondary benefits, through the suggestion that a project be considered from a comprehensive public viewpoint. I feel that there is some advantage to be gained by distinguishing between spillovers and secondary benefits on a basis suggested by Musgrave - spillovers should be acknowledged when a study assumes the national point of view, and that the term "secondary benefits" should be restricted to use in studies where a local or regional viewpoint is adopted.

An interesting argument on the necessity of including secondary benefits in project evaluation is presented in Prest & Turvey (11). Their argument proceeds as follows. Take an example of an irrigation project, resulting in increased grain production which is used in making bread. Primary benefits are measured as the value of increase in grain output less the associated increase in farmers' costs. If the market mechanism is working perfectly, secondary benefits are important only to the extent that the market price of the additional output of the project (wheat) fails to reflect the communities true valuation of the additional output. If this "market price" and the community's true valuation (however it is measured) of the additional wheat production are equal, there is no necessity to consider secondary benefits. Certainly I am in no position to postulate whether or not this condition holds for New Zealand agricultural products.

Overseas Exchange Benefits and Costs

Ward (13) has suggested that the net requirement or contribution of a project for overseas exchange is appropriate to evaluation of large projects in the New Zealand economy, and that an index of the premium on overseas exchange should be applied as a measure of the net benefits or costs from this source. This index would represent the degree of over-valuation of New Zealand currency. Ward has further suggested that these benefits could be both primary and secondary and that it should be possible to calculate foreign currency spent on operating and capital costs. These costs will have been included directly in project economic costs and associated costs and their inclusion in overseas exchange benefits and costs is specifically to measure the social value of the net overseas exchange flow to the nation. They could also be both tangible and intangible.
Farm Development Studies

Studies of the profitability of farm development (meaning intensification) have contributed substantially in recent years to our knowledge of the agricultural sector. These studies have shown the "return" which can be expected from investment in different types of farming situations, and enable conclusions to be drawn which should be helpful to the farmer, the banker, and to the policy maker who should be concerned with the problem of resource allocation.

Farm development studies including as they do, consideration of investment and returns over a period of years, can adequately be evaluated using discounting techniques. Farm development should be regarded as a mini-project. The individual farmer is not normally concerned with the ramifications of his development programme on conditions outside his farm boundary. He must accept input and product prices imposed by economic conditions, and restricts his interest to benefits accruing to the farm firm.

Investment in farm development by a farm operator parallels investment by individuals in a commercial enterprise in other sectors of the economy. In their simplest, and probably most effective form, these evaluation studies depend on the calculation of expected cash flows, and express the results of the study in some monetary terms. Seldom (if ever) is any attempt made to measure the intangible returns to the farmer by way of increased satisfaction, leisure and so on, because of the obvious difficulty of cardinal expression of these benefits. Similarly, spillover effects outside the farm are, by definition, ignored.

Farm development studies are often undertaken in the context of a research programme. In this case, the objective is usually the measurement of the economic desirability of a project, rather than the cash flows and accompanying capital profits. The main distinction between the two approaches lies in the treatment of depreciation. The former approach is of more interest to the economist and would include depreciation as a cost (the consumption of capital or the allocation of capital cost over the useful life of an asset) and the latter of more interest to the farmer might disregard depreciation because of its non-cash nature. A further distinction is the treatment of taxation which would be excluded from the "economic" study but included in the "farmer" study.
Measures of Value

Terms indicating the measures of value in project evaluation are often used interchangeably, and do not appear to have established, precise meanings. The desirability of uniformity of expression in any field is usually accepted; in a field such as project evaluation with a number of workers evaluating a variety of projects for different purposes then need for uniformity is obvious.

Notation:

A suggested notation:

let \( c_1, c_2, \ldots, c_n \) = series of prospective "costs" in years 1, 2, \ldots, \( n \); (measured at the end of each year)

\( c \) = constant annuity with same present value as \( c_1, c_2, \ldots, c_n \);

\( b_1, b_2, \ldots, b_n \) = series of prospective "benefits" in years 1, 2, \ldots, \( n \); (measured at the end of each year)

\( b \) = constant annuity with same present value as \( b_1, b_2, \ldots, b_n \);

\( s \) = scrap value;

\( i \) = appropriate rate of discount;

\( r \) = internal rate of return;

\( n \) = terminal year of project life;

\( V \) = present value of "benefits"

\[
V = \frac{b_1}{(1+i)} + \frac{b_2}{(1+i)^2} + \cdots + \frac{b_n + s}{(1+i)^n} = \sum_{j=1}^{n} \frac{b_j}{(1+i)^j}
\]

\[
C = \text{present values of "costs"}
\]

\[
C = \frac{c_1}{(1+i)} + \frac{c_2}{(1+i)^2} + \cdots + \frac{c_n}{(1+i)^n} = \sum_{j=1}^{n} \frac{c_j}{(1+i)^j}
\]

Present Value of Project \( = \sum_{j=1}^{n} \frac{b_j}{(1+i)^j} - \sum_{j=1}^{n} \frac{c_j}{(1+i)^j} \) (ignoring \( s \))

\[
\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}
\]

\[
= V - C
\]

\( ^6 \) Modified from (11)
Both the $b_j$ and the $c_j$ are in money terms, and could include non-cash allowances converted to these terms.

Internal Rate of Return = discount rate at which

$$n \sum_{j=1}^{n} \frac{b_j - c_j}{(1+i)^j} = 0,$$

or

$$V - C = 0,$$ and solving for $r$.

Both $b_j$ and $c_j$ are often calculated as additional "benefits" or "costs" as compared to a pre-investment stable situation. Four distinct approaches, each deserving distinctive terms can be outlined:

(a) **Individual Viewpoint - Cash Flow Studies**

In these studies, such as farm development evaluation, where cash flows only are considered, and the net cash flows are required, the following terminology is suggested:

- $b_j$ = receipts or expected receipts,
- $c_j$ = payments or expected payments,
- $V$ = present value of receipts,
- $C$ = present value of payments
- $V-C$ = net present value (or private net present value) of project.

This case is similar in effect to the discounted cash flow (D.C.F.) method commonly used by accountants. It has an obvious use in capital budgeting decisions, the calculation of capital profits, and the cash outcomes of investments, and in financing decisions.

(b) **Individual Viewpoint - Including Depreciation or Renewal Funds, and other Non-cash Allowances.**

In these studies, the economic (as distinct from cash) return is usually required. The following is suggested:

- $b_j$ = income or expected income
- $c_j$ = expenditure or expected expenditure
- $V$ = present value of income
- $C$ = present value of expenditure
- $V-C$ = (private) net present value, or (private) present worth of project.
Approaches (a) and (b) would give substantially the same result; (a) provides information for a financial decision, (b) provides economic information for the economist and farm management specialist.

In approaches (a) and (b), $b_j$ would normally represent gross income. The $c_j$ are often calculated to include variable and fixed expenses associated with the investment. $b_j - c_j$ would then represent a cash surplus or deficit in the form of a net cash flow, or net income. If taxation is included in the $c_j$, the $b_j - c_j$ will represent net income after tax or disposable income.

(c) Large Scale Projects – Cash Flow Studies

These studies are based on expected cash flows only, from a regional, industry or national viewpoint, and would include usually only primary benefits with project and associated costs. The following are recommended:

\[ b_j = \text{returns or expected returns}, \]
\[ c_j = \text{costs or expected costs}, \]
\[ V = \text{present value of returns}, \]
\[ C = \text{present value of costs}, \]
\[ V-C = \text{(social) present worth or (social) present value of project}. \]

(d) Large Scale Project – Including Non-Cash Allowances

Both primary and secondary benefits are included, perhaps with some values imputed or simulated, and with allowances for other factors such as net requirement of overseas exchange.

Recommended:

\[ b_j = \text{benefits or expected benefits}, \]
\[ c_j = \text{costs or expected costs}, \]
\[ V = \text{present value of benefits}, \]
\[ C = \text{present value of costs}, \]
\[ V-C = \text{(social) present worth or project}. \]

Modified from Ward (13)
The term "benefits" as defined by the P.W.R.C. and other sources implies a wider meaning than cash returns which flow directly as a result of an investment. The term "benefit-cost" analysis is often loosely applied and frequently used synonymously with "project evaluation". I would suggest further than "benefit-cost" analysis be restricted to project evaluation when a substantial number of non-cash allowances are included in the analysis, and then only for large scale projects. The term "investment analysis" is probably more desirable for cash-flow studies.

In summary:

<table>
<thead>
<tr>
<th>Project Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost/Benefit Analysis</td>
</tr>
<tr>
<td>(Both Cash &amp; Non Cash Dimensions)</td>
</tr>
</tbody>
</table>

The enumeration of calculated V-C and V/C values in some publications has not been clear. I would suggest that the values be specifically stated in terms of the items included in the calculation e.g.

- **Primary V-C and V/C** - including primary benefits only,
- **Secondary V-C and V/C** - including secondary benefits when calculated,
- **Total V-C and V/C** - including all primary, secondary, tangible, spillover and exchange benefits, accompanied by a statement of opinion on the likely magnitude and effect of intangible benefits and spillover effects.

**Time Consideration**

period of analysis is taken as the time over which the project will serve a useful purpose, and the shorter of either the physical life or the economic life of the project. The upper limit would normally be 100 years. Errors of calculation of the period of analysis become less significant as the time period lengthens.

**The Discount Rate**

Space does not allow a full discussion on the meanings of the terms "interest rate" and "discount rate". Masse (7) suggests that the two functions of the interest rate which can be interpreted as the price of money, should be separated. These functions are firstly establishing the terms of exchange between borrower and lender, ultimately determining the amount of saving and therefore the supply of funds on the money market,
and secondly as an element in economic calculation for the purpose of selecting among competing demands for money - by comparing present and future economic values. Masse summarises - "a borrower and lender agree on an interest rate, while a decision-maker uses a discount rate".

However, the literature on both the theory and practice of discounting techniques has interpreted the discount rate in different ways:-

(a) as an opportunity cost, i.e. rate of interest which invested funds could earn in alternative uses. For example, a farmer contemplating investment in additional land and employing discounting techniques to evaluate this as a course of action would be well advised to use as a discount rate the opportunity cost of capital. This could be the rate of return expected from investment in increasing the productivity of his existing farm.

(b) as a rate of time preference, referring to the rate of discount which relates the value of a dollar now to some date in the future. An individual's rate of time preference would be high if he has a strong preference for money now rather than at a later date, or low if his intention is to maximise income at a later time period. The individual's rate of time preference will often differ from the social rate of time preference, which is the rate at which society is considered to relate present and future values of money.

(c) as a cost of capital, i.e. the rate of interest actually paid on borrowed money. Clearly this cost could be substantially different (probably higher) to the individual investing in farm development than to the government or semi-government institutions investing in large-scale projects. The cost of capital to the individual investor has been adequately described in (1,2,9). A weighted average of the cost of each type of capital is usually recommended. An example showing a common method of calculation of the cost of capital is given in Appendix I.

For large-scale projects, Ward (13) suggests that we could consider using the rate of interest on development loans for domestic capital and that on overseas loans for foreign capital. To be more precise we should say the effective rate of interest on current development or overseas loans. The P.W.R.C. (10) recommend that the discount rate be "the average rate of interest payable by the (U.S.) Treasury on interest-bearing marketable securities (of the United States) outstanding at the end of the fiscal year preceding such computation, which upon original issue, had terms to maturity
of 15 years or more. Where the average rate so calculated is not a multiple of one-eighth of one percent, the rate of interest shall be the multiple of one-eighth of one percent next lower than such average rate". If these guidelines were to be adopted for project evaluation work in New Zealand, a discount rate of 5.375 per cent would be employed in 1967-68 financial year. The calculation of this figure is shown in Appendix II. It might be desirable however, because of the rather frequent changes of interest rates to use the next lowest one half of one per cent for discounting purposes.

The fact is that while the problem of discount rate selection is real, some rate has to be selected and this will be a value judgement. Prest & Turvey (11) suggest in this regard "that whatever one does, one is trying to unscramble an omelette and no one has yet invented a uniquely superior way of doing this".

Price Levels

Forward estimates of the prices of inputs into the project and of the prices of goods and services arising from the project are necessary. In the absence of any other acceptable approach, prices of output are normally assumed to be constant. Some recent studies of farm development have incorporated the inevitable phenomenon of rising input prices.
One Method of Calculating the Cost of Capital

The following example shows what is probably the simplest method, and probably as valid as any other measure:

Capital required - $10,000
Source
- Retained Profits $4,500
- Bank overdraft $3,500 @ 6%
- Relatives $2,000 @ 4%

Assuming opportunity cost of retained profits = 6.5% (This can be calculated from the share market for large public companies).

Calculation:

<table>
<thead>
<tr>
<th>Source</th>
<th>Proportion</th>
<th>Cost</th>
<th>(c) = (a)(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained Profits</td>
<td>.45</td>
<td>6.5%</td>
<td>2.925</td>
</tr>
<tr>
<td>Bank Overdraft</td>
<td>.35</td>
<td>6%</td>
<td>2.10</td>
</tr>
<tr>
<td>Loan</td>
<td>.20</td>
<td>4%</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.00</strong></td>
<td></td>
<td><strong>5.825</strong></td>
</tr>
</tbody>
</table>

Appropriate discount rate = 5.825%
APPENDIX II

DERIVATION OF DISCOUNT RATE USING PWRC RECOMMENDATIONS
(for use during 1967-8 Fiscal Year)

Govt. Security Yields:

Long Term (over 10 years))

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>July</td>
<td>5.38</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>5.38</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>5.38</td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>5.37</td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>5.35</td>
</tr>
<tr>
<td></td>
<td>Dec.</td>
<td>5.36</td>
</tr>
<tr>
<td>1967</td>
<td>Jan.</td>
<td>5.36</td>
</tr>
<tr>
<td></td>
<td>Feb.</td>
<td>5.43</td>
</tr>
<tr>
<td></td>
<td>Mar.</td>
<td>5.49 (end of 1966/67 fiscal year)</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>5.50</td>
</tr>
<tr>
<td></td>
<td>May</td>
<td>5.51</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>5.52</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>5.53</td>
</tr>
</tbody>
</table>

Discount Rate would be multiple of \( \frac{1}{8} \) of one per cent next lower than 5.49%, i.e. would be 5.375%.

Reference:


Table:

"Share Prices & Interest Rates:"
Literature Cited:

MEASUREMENT OF BENEFITS AND COSTS
IN FARM DEVELOPMENT STUDIES

Neil G. Gow
Lecturer in Farm Management
Lincoln College

"The evaluation of benefits and costs in each field offers its own set of difficulties." It is the object of this paper to attempt to crystallize the major evaluation difficulties associated with benefits and costs in the field of farm investment. It must be noted that most of the work carried out at Lincoln in relation to farm investment has been concerned with measuring the profitability of farm investment rather than with the ranking of farm investment plans. Certainly it is not the object of this paper to enter into the argument about the selection of the correct criteria for profit maximization. This topic will be discussed at length during later sessions of the seminar. Furthermore it must also be stated that many of the problems discussed are equally applicable to either ex post (historical) or ex ante (future) studies.

1.0 INVESTMENT

The most general definition that can be suggested for the act of investing is that it constitutes the sacrifice of an immediate and certain satisfaction in exchange for a future expectation whose security lies in the capital invested. The term expectation is used because it shows clearly the two-fold aspect of the decision to invest. Firstly it involves the question of time since the expectation lies in the future, and secondly it involves a gamble since expectation and possession are not synonymous. Hence we see as factors in the decision to invest: a subject, who does the investing, an object, which is the capital invested, the cost of time, and the value of an expectation. The body of literature concerned with investment analysis is voluminous and to a major degree is primarily concerned with portfolio and industrial investment. As a result of this the process of investment has normally been broken down into three main classes:

a) POINT INPUT-POINT OUTPUT

Where capital is invested at one specific point of time and the returns accrue to it at some other specific point of time, e.g. wine allowed to age and mellow in a cellar.
b) CONTINUOUS INPUT - POINT OUTPUT

Where capital is invested over successive periods of time and the return is concentrated in one period of time, e.g., the subdivision of urban land, or a forest taken to maturity.

c) POINT INPUT - CONTINUOUS OUTPUT

Where a single injection of capital gives off a continuing stream of benefits, e.g., the purchase of a tractor.

As will be immediately obvious, most farm development falls into a fourth class, that of continuous output. This is the first reason why the evaluation of benefits and costs of investment in farm development raises its own set of difficulties. This problem is further exacerbated by the fact that many farm development projects involve investment in a farm unit which is already economically viable, or at least an operating economic entity in its own right. Thus we are faced with the problem of deciding upon some base or status quo situation existing without the planned investment taking place, and measuring the results of the investment against the base. This 'with and without' principle is defined by Eckstein as 'no more than a restatement of the fundamental analytical idea that any action be evaluated in terms of the difference it makes, that is, in terms of the effects which it specifically causes.' In Eckstein's view the 'with and without' principle is superior to the 'before and after' principle because it prevents effects being attributed to a project that are not caused by it. In most of the Lincoln work the 'without' situation has been arrived at by adjustment to the 'before' situation. In ex post studies windfall gains caused by output price fluctuations not backed by productivity increases can in certain situations have a very significant effect on the apparent profitability of farm development (see Gow pp. of these Proceedings).

Lawson has taken this a stage further by allowing a current farm management plan which involves some degree of development to work itself out, and thus he superimposes a new development plan on a moving base. To me this is a good example of the correct application of the 'with and without' principle where the 'without' situation cannot be easily formalized.

2.0 CAPITAL VERSUS MAINTENANCE

The preceding discussion of the 'with and without' principle leads quite naturally on to the question of distinguishing capital from maintenance expenditures. Because of the continuous nature of farm development investment and the complex nature of the
physical input relationships involved, both known and suspected, the clear division between capital and maintenance expenditures possible in industry cannot be postulated for agriculture. Attempts have been made at Lincoln to produce this division but the consensus of opinion is that such an analysis is usually spurious. The agricultural production process is characterised by complementary relationships between inputs, and further complicated by lagged effects associated with certain key inputs (e.g., fertilizer). Thus any division of capital and maintenance expenditures on a detailed basis tends to be based on a convention rather than on the basis of productivity. Because of this the present method of using a total status quo situation (with its fixed relationships between inputs and outputs) as a benchmark, and inputing the variations from this, as the benefits and costs associated with development, appears to be as accurate as one can be from the standpoint of economic theory. On the basis of Euler's theorem even this assumption has certain quite severe logical deficiencies.

2.0 DURABLE GOODS OR INDIVISIBLE INVESTMENTS

The suggestion made in the previous section was that division between capital and maintenance expenditure is extremely difficult except on a very broad basis. Having said that it must be admitted that the problem is still a very real one, particularly as some forms of farm investment are fixed in size and lumpy in nature, i.e., they are durable or capital goods of a certain form. 'It is a characteristic of durable goods that they comprise a bundle of inputs (or cost units) which produce a stream of outputs coming forth over a sequence of short periods, and, as Wicksell and Hayck have emphasised, there is in most instances no way of linking particular units of input with particular units of output. All that we can say is that all inputs embodied in the durable good are jointly responsible for the whole stream of output'. Or as Wicksell has said with reference to this same 'durable goods' problem 'the annual uses successively following one another constitute a kind of joint supply .... and fundamentally it is just as absurd to ask how much labour is invested in either one or other annual use as to try to find out what part of a pasture goes into wool and what part into mutton'. The whole problem of estimating the short run cost of a durable good arises because someone wants the answer to an ambiguous question, namely 'what are the farms' net earnings or profits for an interval of time which is very short compared to the investment period of capital employed by the farm? This is essentially the same question which must be asked when we are attempting to set up a post development status quo situation for capitalization into a residual value. The difference being that in the status quo situation we have to make some allowance for the replacement of fixed capital employed (e.g., plant) which we know will have to be replaced sometime in
the capitalization period. To neglect this problem is to compound the error, to overestimate the problem is to undervalue the residual or status quo value. Thus the existence of durable goods in a farm development programme, some of the benefits of which are assumed to continue in perpetuity, means that the question of depreciation must be solved.

4.0 DEPRECIATION

Depreciation has a variety of meanings but the most common one is 'the periodic reduction in the value of a fixed capital asset'.6 It is at this point that accountants and economists go their separate ways. Accountants regard the cost of a durable good as a prepaid operating expense to be apportioned among the years of its life by some more or less systematic procedure (i.e., depreciation accounting). Thus the accountants' method of depreciation is a process of cost allocation not of asset valuation. The economist on the other hand would add a rider to the definition above; namely that the reduction in value of an asset is 'a reduction which arises from a change in the asset's future earning power'.7 That is, they accept Fisher's statement that 'it is only when we know what amount of income a given capital asset will probably yield that it becomes possible to estimate the value of that capital.' It is true that the grain harvest depends on the land and the soil that produce it. But the value of the harvest is not a function of the value of the land. The value of the land, on the contrary, depends on the presumed value of the harvests'.8 Thus whereas the value of a capital good to an accountant at any point in time is equal to its book value (or more correctly its unamortized cost), to an economist its value will depend on the stream of future benefits it can give. Hudson and Mathews point out that in order to measure 'depreciation it is necessary to estimate, at different points of time in an asset's life (e.g. end of each financial year) the stream of future net services (i.e. gross returns less operating and maintenance costs) which the asset is expected to yield over the remainder of its working life, including as one item the asset's estimated scrap value at the time of sale. The expected stream of services at each point in time is then converted to a discounted value at that point, and the depreciation between any two points is simply the difference between the discounted values of future net services at those points of time'.9 As with all discounting procedures the definition of the appropriate discount rate is a difficult problem. Hudson and Mathews use the internal rate which makes the present value of the expected stream of net services at the time when the asset is originally purchased exactly equal to its cost. The internal rate resulting from this method therefore defines the rate of depreciation of the asset. This method is not always appropriate because it implies that the depreciation allowances are re-invested at an interest rate equal to 'r'. In this latter case 'a rate of return on the asset in question can be defined at the maximum earning rate consistent with maintaining
The capital invested in the asset. The depreciation charge for any period can then be calculated as the value of the asset's net services in the period plus interest earned on previous depreciation provisions at the rate appropriate for 're-invested' funds minus profit for the period (where profit equals the defined rate of return on the original capital invested in the asset).'

In general terms, if an asset produces a net service of $b-c$ per annum over $t$ years, its present value equals:

$$\frac{b-c}{r} \left( 1 - \left( \frac{1}{1 + r} \right)^t \right)$$

The same asset after one year will only be expected to produce a net benefit of $b-c$ per annum for $(t-1)$ years, and its value at that point of time equals:

$$\frac{b-c}{r} \left( 1 - \left( \frac{1}{1 + r} \right)^{t-1} \right)$$

Thus its depreciation for the year equals:

$$\frac{b-c}{r} \left( 1 - \left( \frac{1}{1 + r} \right)^t \right) - \frac{b-c}{r} \left( 1 - \left( \frac{1}{1 + r} \right)^{t-1} \right)$$

$$= \frac{b-c}{(1+r)^t}$$

Where $t$ equals the remaining expected life of the asset, at the beginning of the period in question. The implications of this formula are, firstly, that the depreciation charge per year will rise as $t$ falls, secondly, that the depreciated value of the asset at any point of time reflects the expected future net services, and thirdly that the sum of the depreciation charges over all periods of the asset's life equals the original purchase price. But perhaps the most important feature of the formula is that it can result in constant or straight line, reducing, or increasing depreciation charges over the asset's life. The final pattern of depreciation will depend on the predicted pattern of net services and the discount rate used.

4.1 ACCOUNTANTS METHODS OF DEPRECIATION

Accountants tend to use one of three methods for calculating their concept of depreciation. The three methods are commonly known as: straight line, diminishing balance and sum of years digits.

4.1.1 STRAIGHT LINE DEPRECIATION -

This method assumes that the cost of an asset will be paid off in equal instalments over the life of the asset.
i.e. Straight line rate = \( \frac{\text{Initial Cost} - \text{Salvage Value}}{\text{Estimated Life in Years}} \)

\[ \text{Depreciation} = \frac{300}{3} = \$100 \text{ per year} \]

In terms of the Hudson and Mathews formula this straight line depreciation rate implies a gradually declining periodic undiscounted net benefit stream resulting from the need for increasing maintenance expenses in the later years of the asset's life.

<table>
<thead>
<tr>
<th>Year</th>
<th>Future Net Benefit</th>
<th>Begin</th>
<th>End</th>
<th>End</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$300</td>
<td>$130</td>
<td>$120</td>
<td>$110</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$200</td>
<td>$200</td>
<td>$100</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
<td></td>
</tr>
</tbody>
</table>

Discounted Future Net Benefit at beginning Year 1

\[ \text{Discounted Net Benefit} = (130 \times 0.9091) + (120 \times 0.8264) + (110 \times 0.7513) = 118.2 + 99.2 + 82.6 = 300 \]

The requirement in general terms for the formula to give a straight line depreciation rate is that the undiscounted net benefit stream must decline linearly as follows:

\[ K \times e^{l + rt} = K \times e^{l + r(t - 1)} \]

where \( K \) is the original purchase price
\( t \) is the life of the asset
\( r \) is the internal rate of return

\[ 4.1.2 \quad \text{DIMINISHING BALANCE DEPRECIATION} \]

this method assumes that the depreciation of an asset will be a constant percentage of its declining depreciated value, and implies that an asset contributes more to income in its early years of life than in its later years. It also assumes some positive scrap value for the asset at the end of its useful life since a diminishing balance depreciation curve is asymptotic to the zero axis.
e.g. Assume a positive scrap value of $37.5 for a $300 asset after 3 years.

<table>
<thead>
<tr>
<th></th>
<th>Begin</th>
<th>End</th>
<th>End</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Net Benefit</td>
<td>-</td>
<td>$180</td>
<td>$90</td>
<td>$45</td>
</tr>
<tr>
<td>Scrap Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$300</td>
<td>$150</td>
<td>$75</td>
<td>$37.5</td>
</tr>
<tr>
<td>Discounted F.N.B.</td>
<td>(r = 10%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>-</td>
<td>$150</td>
<td>$75</td>
<td>$37.5</td>
</tr>
</tbody>
</table>

If \( \phi \) equals the annual percentage rate of decrease which will reduce the original cost of an asset to its scrap value after \( t \) years then the pattern of undiscounted future net benefits required to give a diminishing rate of depreciation would have to be of the general form:

\[
K (r + \phi); \quad K (r + \phi)(i - \phi); \ldots; \quad K (r + \phi)(1 - \phi)^t - 1
\]

4.1.3 **SUM OF YEARS - DIGITS METHOD**

In this method the digits corresponding to the number of years of estimated life are added together, and the sum is used as the denominator in a fraction which is applied to the original cost in order to determine the annual depreciation charge.

e.g. Asset cost $300, \( t = 3 \) years

\[\text{'. Sum of digits} = 1 + 2 + 3 = 6\]

\[\text{''. Depreciation in the first year} = \frac{3}{6} \times $300 = $150\]
\[\text{second year} = \frac{2}{6} \times $300 = $100\]
\[\text{third year} = \frac{1}{6} \times $300 = $50\]

Thus this method writes off about 75% of the depreciation in the first half of an asset's life.
Future Net Benefit
Discounted F.N.B. (r = 10%)
Depreciation

<table>
<thead>
<tr>
<th>Year</th>
<th>Begin</th>
<th>End</th>
<th>End</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>$180</td>
<td>$115</td>
<td>$55</td>
</tr>
<tr>
<td>2</td>
<td>$300</td>
<td>$150</td>
<td>$50</td>
<td>$0</td>
</tr>
<tr>
<td>3</td>
<td>$150</td>
<td>$100</td>
<td>$50</td>
<td></td>
</tr>
</tbody>
</table>

In general terms this method is appropriate when the undiscounted future net benefits are expected to decline in the following fashion:

\[
\frac{2K}{t(t+1)} \frac{r(t+1)}{2} \frac{2K}{t(t+1)} \frac{(t-1)+r(t-1)}{2} \frac{2K}{t(t+1)} \frac{t(t-2)(t-1)}{2} \frac{2K}{t(t+1)} \frac{1+r}{2}
\]

4.1.4 SINKING FUND

American literature on Benefit Cost analysis mentions the use of sinking funds in order to calculate depreciation charges. Under this system an imaginary sinking fund would be established by uniform end of year deposits throughout the life of the assets. These deposits are assumed to draw interest at some stated rate of interest sufficient that the fund will equal the cost of the asset minus its estimated salvage value at the end of its estimated life. The formula for this is:

\[
A = \frac{S_n i}{(1+i)^n - 1}
\]

Where \( A = \) annuity \( S_n = \) future lump sum accruing at the end of \( n \) years.

The amount charged as depreciation in any one year consists of the sinking fund deposit (annuity) plus the interest on the imaginary accumulated depreciation fund. This method is sometimes called the PRESENT WORTH method - i.e. the book value of an asset at any time is equal to the present worth of the uniform annual cost of capital recovery for the remaining years of its life plus the present worth of its prospective salvage value.

e.g. Asset Cost = $35,000 Salvage Value = $3,500

\[
n = 20 \text{ years} \quad i = 6\%
\]

\[
A = \frac{(35,000 - 3,500) \times 0.06}{(1 + 0.06)^{20} - 1}
\]

\[
= $856
\]
## DEPRECIATION CHARGE FOR YEAR

<table>
<thead>
<tr>
<th>Year Balance</th>
<th>Diminishing Year</th>
<th>Diminishing Years</th>
<th>Straight 6% Sinking Fund</th>
<th>Diminishing Year</th>
<th>Diminishing Years</th>
<th>Straight 6% Sinking Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35,000</td>
<td>35,000</td>
<td>35,000</td>
<td>35,000</td>
<td>35,000</td>
<td>35,000</td>
</tr>
<tr>
<td>1</td>
<td>35,000</td>
<td>3,500</td>
<td>1,575</td>
<td>856</td>
<td>31,500</td>
<td>32,000</td>
</tr>
<tr>
<td>2</td>
<td>35,000</td>
<td>3,150</td>
<td>1,575</td>
<td>908</td>
<td>28,350</td>
<td>29,150</td>
</tr>
<tr>
<td>3</td>
<td>35,000</td>
<td>2,835</td>
<td>1,575</td>
<td>962</td>
<td>25,515</td>
<td>26,450</td>
</tr>
<tr>
<td>4</td>
<td>35,000</td>
<td>2,551</td>
<td>1,575</td>
<td>1,020</td>
<td>22,964</td>
<td>23,900</td>
</tr>
<tr>
<td>5</td>
<td>35,000</td>
<td>2,297</td>
<td>1,575</td>
<td>1,081</td>
<td>20,667</td>
<td>21,500</td>
</tr>
<tr>
<td>6</td>
<td>35,000</td>
<td>2,067</td>
<td>1,575</td>
<td>1,146</td>
<td>18,600</td>
<td>19,250</td>
</tr>
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A comparison of the effect of the four methods of depreciating an asset is given in the following table. This comparison is for an asset costing $35,000 with an estimated life of 20 years and an estimated salvage value of $3,500.

Hudson and Mathews reach the conclusion 'it is clear that there is no general case for any individual method of depreciation. Possible patterns of the distribution of depreciation charges over an asset's life are unlimited, and which one of the methods commonly in use gives the best approximation depends on the rate of return and on the pattern of undiscounted net services expected to accrue over the asset's life'.

**ECONOMISTS' VIEW OF DEPRECIATION**

Vernon L. Smith states 'discard an incumbent asset in favour of the most attractive alternative commitment if the net contribution to the present worth of the enterprise due to holding the asset an additional year does not exceed the external market value of the asset. The complement of this rule is to hold the asset an additional year if the resulting contribution to net worth exceeds the market value of the asset'. Or to express it another way 'an asset should be held until its marginal internal value to the enterprise from another year's service no longer exceeds its external market value'.

As will be immediately obvious the foregoing statements have been written in the context of investment timing, but they are relevant to the question of benefits and costs of farm development, because in essence they embody the same general approach as Hudson and Mathews.

**PREINREICH-LUTZ-TERBORG THEORY**

These writers point out that in the short run the revenue accruing to a durable good is residually determined. They suggest these short run payments are in fact quasi-rents, i.e. they are payments to a factor of production which are economic rent in the short run, and transfer earnings in the long run. They base this contention on the concept that in
the short run output is determined by marginal cost and marginal revenue. This implies that the costs of the durable good do not enter into the determination of output in the short run. If the average revenue exceeds the average total cost, the quasi rent from the durable good will exceed its cost and profits will be made, and vice versa. In the long run if the average total cost of the product remains above its price so that the quasi-rent of the durable good falls short of its fixed costs, then the durable good which is wearing out will not be replaced. Lutz suggests the use of a capitalization formula which avoids the use of the depreciation charge as a cost item, and the use of the average fixed cost curve, entirely. Under this method the only cost curves we need to construct for determining the prospective profitability of investing in fixed equipment are the estimated short run marginal cost curves for the successive unit periods. These curves, combined with the corresponding marginal revenue curves, give us the successive outputs for the periods and the successive (residual) revenues attributable to the fixed equipment or durable good, i.e., its quasi rents. This series of prospective quasi rents discounted at the market rate of interest gives us the estimated capital value ($V$) of the equipment. By comparing this with the initial cost ($K$) of installing the equipment, we can tell whether it is profitable to install it. The difference between $V$ and $K$ we may call, following Preinreich, the 'goodwill' of the equipment. If $V$ is just equal to $K$ the goodwill is zero and fixed costs are covered, but if $V$ is less than $K$ then goodwill is negative and since fixed costs are not covered the equipment will not be bought or renewed.

Let

\[
\begin{align*}
Q_t &= \text{quasi-rent of a durable good in any unit period } t \ (t = 1, 2, \ldots, T) \\
P_t &= \text{the market price of the product} \\
q_t &= \text{the number of units of output produced and sold in the unit period} \\
E(q_t) &= \text{the variable or operating costs (exclusive of depreciation and/or interest charges on the fixed equipment) as a function of the number of units of output produced in the unit period} \\
T &= \text{the machines scrapping date} \\
i &= \text{the rate of interest (here assumed to be constant)}
\end{align*}
\]

In each unit period

\[
Q_t = P_t q_t - E_t (q_t)
\]
Therefore the present value of the whole series of quasi-rents thus determined, plus the present value of the scrap value \( S \) is then

\[
V = \frac{q_1}{(1+i)} + \frac{q_2}{(1+i)^2} + \ldots + \frac{q_T}{(1+i)^T} + \frac{S}{(1+i)^T}
\]

If we set \( V_0 = K \) (\( V_0 \) = value of good at time of installation) and treat \( i \) the rate of discount as the unknown then we can solve for that rate, which will under this condition be the internal rate of return \( r \).

4.2.2 EQUIVALENCE OF \( V_0 \) AND \( K \)

Wicksell and other authors conclude that the only possible method of valuing a partly used-up durable good is to capitalize its remaining earnings at the market rate of interest. If the assumption that \( V_0 = K \) is not appropriate (i.e. that \( V_0 \) is greater than or less than \( K \)) then the application of Lutz's capitalization formula will cause depreciation equal to \( V_0 \) rather than to \( K \), i.e. the goodwill is part of the capital to be maintained. Thus if \( V_0 \) is greater than \( K \) and if we assume that \( K \) is to be maintained then the whole of the goodwill must be counted as income at \( t = 0 \) and must be consumed at that date. If the goodwill is not consumed, at \( n = 0 \), we may say that, by being saved it adds to the amount of the investor's capital, and that this increased capital is henceforth the amount which he wishes to maintain intact. If the internal rate of return \( i \), instead of the market rate of interest \( r \) is used as the discount rate a difficulty will arise so long as \( i \) is greater than \( r \). This difficulty is that under this assumption the book value for the asset in each period will be below the present value of the asset's future quasi-rents. Lutz favours using the assumption 'that the capital sum which the investor desires to maintain intact is \( V_0 \) and thus the net income (quasi-rent) in each period is then equal to the interest rate \( r \) times the capital sum \( V_0 \).'

Smith formulates the Preinreich-Lutz-Terborg theory as an investment decision rule of the following form:

\[
H_0(Lo) = \frac{R_0(Lo) + M_0(Lo) + \frac{q_0}{q_0+q_0}}{r} + V^1 \leq M_0(Lo)
\]

where \( H_0(Lo) \) = the net contribution to the present worth of the enterprise of holding a sunk investment \( Lo \) additional years.

\( M_0(Lo) \) = market value (salvage or resale) of the asset at \( Lo \), i.e. the contribution to present worth that will result from sale.
\[ R_0 \left( \frac{L_0}{r} \right) = \text{the capitalized value of the assets expected net earnings in year } L_0 \]

\[ M_0^T \left( \frac{L_0}{r} \right) = \text{the capitalized value of the asset's expected decline in market value that year, (this com-} \]

\[ B_0^T \left( \frac{L_0}{r} \right) = \text{the capitalized value of the expected technological change benefits obtained by delaying reinvestment an additional year (such a delay permits the pur-} \]

\[ V^1 = \text{the present worth of the expected future net income stream of the reinvestment asset and its chain of replacements.} \]

Put in simple terms this decision rule states that 'the first three enumerated components of \( R_0 \left( \frac{L_0}{r} \right) \) provide the gross contribution of the asset to the firm's present worth. From this is subtracted \( V^1 \), which is an opportunity cost of not reinvesting at \( L_0 \), to arrive at the net present worth contributed. When the internal net worth contributed by holding the asset no longer exceeds its market value, the asset should be replaced.

### 4.2.3 CONCLUSIONS

1. The Hudson and Mathews and the Lutz formulae are the same if \( Q_t \) is defined as equal to \( b-c \). In both cases if the discount rate (\( i \)) is the internal rate of return (\( r \)) then \( V_0 \) will be equal to \( K \). If \( i \) is not the internal rate of return (\( r \)) then \( V_0 \) will not equal \( K \), and the depreciation charge will keep \( V_0 \) rather than \( K \) intact.

2. Where a constant or straight line depreciation charge is used in the post development status quo budget to determine the surplus to be capitalized then the implication is that the stream of undiscounted net benefits accruing to the durable good are declining linearly.

3. If the objective of the depreciation charge is to estimate the present value of a good on the basis of its transfer earnings then this implies that \( V_0 \) is to be kept intact rather than \( K \).
4. If the absolute size of the depreciation charge is likely to have a substantial effect on the value of the capitalized post development surplus, then it may be better to treat it separately rather than bring it in the overall surplus figure, i.e. instead of expressing depreciation as an annual figure, express it as an amount of capital to be kept intact, and subtract this figure from the capitalized value of the post development status quo cash surplus.

5.0 RESIDUAL VALUES

In the discussion of depreciation reference was made to the term salvage or scrap value. This was an admission that a durable good exhibits the 'possibility of substantial end of life capital value'. This end of life value is often overlooked in the appraisal of an internal investment proposal. The reasons for this neglect could be due to:

a) the long economic life of the durable good - i.e. the ultimate monetary realization is too far away to have any effect on present investment decisions.

b) the probable scrap value is so low that it can be safely ignored.

c) the available data do not provide an adequate base for forecasting.

d) the future is so uncertain that changing conditions may wipe out whatever values now seem probable.

All of these reasons have some point in relation to farm development programmes, but before this problem is discussed in more detail, it is appropriate to further clarify the term scrap value. Shillinglaw talks of residual value and prefers this to scrap or salvage value because he contends that residual value 'may include everything that produces or retains a cash or opportunity cost value at the time the physical facilities contemplated in the investment proposal are retired, replaced or relegated to stand-by status'. He further contends 'they are usually positive in amount, but sometimes they may be negative'. It seems to me that residual value is the appropriate term for end-of-life capital values for land development proposals, since land may have a significant end of period value which does not have to be sold in order to be realised, i.e. the investor can realise part of his increased equity by borrowing against it. If we accept this definition then it can be clearly stated that residual value is of great importance in land investment. For as Shillinglaw says 'the value of land may in some instances rise sufficiently to justify relatively low incremental earnings during the projects
life'. Work at Lincoln confirms this statement (see Gow pp of these Proceedings).

The preceding statements on residual value are recognition of the fact that in land development returns accrue to investment in the form of income and capital gains. The definition of capital gains can be handled in one of two ways. Firstly, as is common at Lincoln the post development status quo surplus can be capitalized, or secondly estimates can be made of the estimated residual value after sale at the end of the investment period. In the first case the residual value is the present worth of a future income stream \((V_t)\) and in the second residual value is a measure of the external investment value \((K_t)\). As was pointed out in the discussion of depreciation \(V_t\) and \(K_t\) are not necessarily equal. Economists because of their concept of value tend to use the capitalization approach, although it must be said that the second approach approximates to Boulding's idea of the dynamics of the balance sheet. Regardless of which method of determining residual value is used, it will only have a significant effect on overall profitability if the investment is a marginal proposition without it. Where the investment is highly profitable and the residual value is well in the future then there may be no practical gain from measuring it. That is, the effect of residual value will be determined by the discount rate used, and the planning horizon envisaged. Even if we accept the preceding proposition the merit in measuring residual values must not be overlooked, since although it is generally not feasible to achieve complete precision in the estimates of residual value, great precision is not necessary; because the effect of time on present values is such that fairly substantial error ranges in the estimates can generally be tolerated. A customary assumption is that residual values will remain constant through time and that ultimate realization will equal the initial outlay for the land. Many land investors have made substantial profits disproving this point.

6.0 THE ROLE OF CONSERVATISM

Because all investment proposals deal with expectations, and since these (particularly residual values) may be well in the future the alleged need for 'conservatism' is sometimes advanced as a justification for ignoring or sharply discounting future residual values. The implication of this argument in its crudest form is that in a dynamic environment it is impossible to predict future economic circumstances and that therefore the only way to avoid mistakes is to predict the worst. Carried to its logical extreme, this argument would mean that no investment should ever be undertaken unless it is accompanied simultaneously by instantaneous net cash receipts equal to or greater than the investment outlay.
Provided the argument is not taken to its logical extreme it has some point, since every estimate is subject to a range of error. Because of this it may be desirable to apply a greater discount for risk to distant realizations than is implied by the overall discount rate which already contains an allowance for risk. To compound this by ignoring residual values would be unnecessarily restrictive on capital expenditure. Similarly to lower estimates of benefits in the post development status quo budget on the grounds of conservation and to also introduce a risk premium may lead to an unnecessary pyramiding of risk allowances. As Shillinglaw so aptly says 'a wise conservatism is to evaluate the future, a false conservatism is to ignore it.' More will be said about the question of risk and uncertainty by Mr Cleland in Session.

In the case of farm development it is important to realise that the individual farmer (the subject) who does the investing has his own particular risk aversion and debt servicing capacity. It seems to me that the role conservatism is to play in an investment study must be interpreted in relation to these two factors.

7.0 EFFECT OF TAXATION

The effects of present rates of taxation on the profitability of the individual farmer's development programme are considerable, particularly if the objective is to maximise the income effect of development. Should the Ross Committee's recommendation of a capital gains tax be implemented then the income effect would be even more important. It is not the intention of this paper to give a critical appraisal of the effect of taxation on the profitability of farm development as this has been carried out by Cartwright. The point must be made however, that because of our present tax laws the profitability to the farmer and to the nation are not necessarily the same. Thus in any individual land development scheme the impact of taxation can be critical to the net benefits accruing to the individual investor.

8.0 EFFECT OF TECHNOLOGY

On the basis of history it must be recognised that changes in technology will confer a net benefit on most development plans - particularly if they have an extended planning horizon. From historical data it is possible to calculate a rate of technological change and this rate should be taken into account in the setting of any risk premium. The so called 'stocking rate revolution' has undoubtedly made a significant contribution to the profitability of farm development in the past and will undoubtedly continue to do so in the future.
9.0 DEFLATION OF HISTORICAL DATA

Where an ex post study based on accounting records is being attempted then one of the major problems to be resolved is how to convert money values into real values. If all the physical quantities used in the development programme are available then a series of constant prices can be applied to these physical quantities in order to derive the required real values. Unfortunately most accounting data does not provide this information, thus the derivation of real values relies on the use of a price index. The most useful index for farm costs in New Zealand is the one published by the New Zealand Meat and Wool Boards' Economic Service but this, like most general indices, has a number of weaknesses. The most important of these is that it is based on a specific input mix which may or may not be representative of the input mix used in the particular development programme under review. It is however weighted for type of farming (e.g. High country, hill country etc.) according to average patterns of expenditure. For any given project it would be possible to derive a cost index, but this is very time consuming, and probably gains little in accuracy in comparison to the Econserv index. On the output side diligent research normally produces enough information for real values to be calculated quite accurately.

10.0 GENERAL CONCLUSIONS

This paper, "The Measurement of Benefits and Costs in Farm Development Studies" has been based on the assumption that seminar members are familiar with the criteria for evaluating investment profitability, and the need for definition of a status quo situation when further investment is being imposed on an already viable economic unit. In the body of the paper a number of seemingly diverse topics have been covered, all of which, however, have some bearing on the subject of the paper. The implications raised by these topics can be summarised as follows:

1. Because of the problems of complementarity of inputs and technological change, and because in most cases we are dealing with an already viable economic unit, the problem of distinguishing investment and maintenance expenditure is best handled in a broad way. That is, by defining a status quo situation and using that as a base level for measuring the benefits and costs associated with investment.

2. Because of the adherence to Eckstein's 'with and without' principle it is acceptable to use a moving status quo situation. This is particularly applicable to situations where the pre-development level of costs and returns already involves a measure of unexploited development.
3. Because investment in farm development involves income and capital effects the question of residual values must be faced. Furthermore, if this involves capitalization of a post development surplus then some care must be exercised in defining this surplus, particularly in relation to the maintenance of partially used indivisible investments or durable goods.

4. In both the pre and post development status quo budgets it is appropriate to make allowance for a depreciation charge. In the development phase the depreciation charge can be ignored as the depreciation of status quo plant has already been covered, and any further change is unlikely to be separately funded, i.e. in a profitable development programme the opportunity cost of a separate depreciation fund for additional plant is likely to be above the interest which the depreciation fund could earn outside.

5. Because the planning horizon is likely to be well in the future some notice must be taken of risk and uncertainty. To avoid a pyramiding of risk allowances the best way to achieve some allowance for these factors would seem to lie in suitably adjusting the discount rate.

6. Because an individual investor is involved, the effect of taxation should be evaluated, which of necessity means each project will be specific to one individual. This individual is also important in relation to his risk aversion and debt servicing capacity. Thus the scale of the project and the time period involved may have to be tailored to the individual.

It is quite obvious from the foregoing remarks that farm development as a sector of Benefit-Cost analysis does have its own set of difficulties. Furthermore, because of the individual nature of each farm development programme the general principles of measuring benefits and costs may have to be modified to suit particular investment proposals.
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BENEFIT-COST ANALYSIS AND
AGGREGATION PROBLEMS

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In their admirable survey of the field Prest and Turvey (10) emphasize that benefit-cost analysis is theoretically a straightforward exercise as long as perfectly competitive conditions hold. If there is a departure from these conditions problems start to pile up. Many of these arise because in benefit-cost analysis we are trying to use "investment decision rules derived from a perfectly competitive state of affairs to a world where such a competitive situation no longer holds" (10, p.693). The purpose of this paper will be to briefly outline some of the difficulties that can arise even given competitive conditions. Time prevents treatment of the problems posed by the absence of perfect competition.

In Australia and, I gather, New Zealand the major applications of benefit-cost analysis have been in the appraisal of large-scale land development projects typically involving many firms (e.g. 4). The two problems which will be examined in this paper can be very important in such studies. One of them is theoretical, the other is essentially a problem of measurement.

Market Effects and the Measurement of Benefits and Costs

In this section partial equilibrium analysis will be used, in a simple way, to describe the sort of thing we, as benefit-cost analysts, want to measure. The model used will illustrate what happens in a simple market situation following a change in production possibilities. This is a typical benefit-cost situation, although the market is usually not so simple.

First of all, before the change, there are the demand and supply curves for a commodity, DD and SS, as depicted in Figure 1. The demand curve is the schedule of prices which consumers are willing to pay for successive units of the commodity. The area under the demand curve is assumed to represent the total value, or utility, of the commodity in consumption. For example, consumption of OQ1 of the commodity should afford a total utility to consumers of OQ1 ED.

The supply curve is the schedule of prices at which successive units of the commodity will be offered on the market and the area under
the curve represents the total cost, or utility foregone, of producing any quantity of the commodity. Thus, in order to produce output \( OQ \), a total cost of \( OSEQ \) must be incurred or, in other words, production of \( OQ \) of the commodity involves the sacrifice of \( OSEQ \) of utility elsewhere in the economy.

As is usual, the intersection of these curves determines the equilibrium output, consumption, and price. The equilibrium quantity in Figure I is \( OQ_1 \) and the equilibrium price is \( OP_1 \).

Let us now assume that, following some developmental investment in the industry, there is an upward shift of the production function and a resulting shift of the commodity supply curve to the right to the new position indicated by \( S_1 \) in Figure I.

![Figure I: The Effects of a Shift in the Supply Function in a Simple Market Situation.](image)

This shift in the supply curve would bring about a new equilibrium in the market at \( E_1 \) with price \( OP_2 \) and output \( OQ_2 \). The benefit-cost analyst would be interested in determining the effect of this change, an effect which could be difficult to determine in view of the decline in commodity price and the rise in unit costs which have been accompanied by an increase in output.

Under the old market situation the total value created in the hypothetical market by the production of \( OQ \) of the commodity was, as we have seen, \( ODEQ \). Of this total we have also seen that \( OSEQ \) reflects the total cost of producing \( OQ \). The triangle \( SEP \) is a return to the producers of the commodity net of the costs they incurred. This area is referred to as the producers' surplus or rent. The remaining area \( DP_1E \)
is the utility derived by the consumers from the purchase of OQ, of the commodity which is not cancelled out by payments. This last area is referred to as the consumers' surplus.

In assessing the effect of any change the benefit-cost analyst would in general be interested in measuring the net effect on each of the cost of production, the producers' rents, and the consumers' surplus. Even in our simple model this is quite a complex process, at least conceptually. Let us examine our three divisions in total value in turn.

(a) Consumers' surplus: The increase in consumer's surplus is $P_2P_1EF$. Of this area $P_2P_1EF$ is a self-cancelling transfer payment from the producers to the consumers and so the net increase in consumers' surplus is the area $FEE_1$.

(b) Producers' rents: The changes here are somewhat more complicated but in effect the producers lose $P_2P_1EF$ which becomes a self-cancelling gain to the consumers, and they gain the area $S_1SFE$ which is the net gain in producers' rents, as long as the economy is fully employed.

(c) The cost of production: These have decreased by $S_1SEC$, which area has been allocated between producers' and consumers' surplus, as has been seen. There has also been an increase in costs which is represented by the area $Q_1CEQ_2$.

So the net benefits of the scheme are the sum of the net changes in producers' and consumers' surpluses minus the net increase in cost of production. That is:

$$\text{Net benefits} = FEE_1 + S_1SFE - Q_1CEQ_2.$$ 

The benefit-cost analyst would be interested in evaluating these various changes in order to arrive at his measure of net benefits.

As has been indicated, this has been a generalized, though simplified, presentation of the general classes of benefits and costs involved where the development under study brings about non-marginal changes in output and/or resource use.

1 If the commodity under study is wholly exported, then any increase in consumers' surplus is no gain to the producing economy. In such a case the area $FEE_1$ should not be credited to the project and the area $P_2P_1EF$, instead of being ignored, should be debited against the scheme because it is a loss to the domestic producers and hence to the nation.
The conventional benefit-cost study of a land development scheme is based on an analysis of a case or representative farm with the conclusions about the scheme being drawn from individual farm results. However, as far as the social decision process is concerned, it is the total aggregate gains and costs of the scheme which are crucial.

It would seem, however, that there will be occasions when the aggregate effects of the scheme are such that the usual assumption of perfectly elastic output demand and input supply are unacceptable. Such a situation is depicted in our simple model. In these cases there is an interdependence between firm organization and the aggregate effects of the scheme which may need to be recognized if seriously biased results are to be avoided.

The type of situation which is typically assumed in conventional benefit-cost studies is portrayed in Figure 2. Here consumer demand is assumed to be perfectly elastic (constant product price is assumed).

\[ \text{Figure 2: Effect of a Shift in the Supply Curve with Product Demand Perfectly Elastic.} \]

The important thing to note here is that consumers' surplus has zero value before and after the shift and so does not enter into our calculations. The only relevant comparison is between the change in producers' surplus \( S'S' \) and the net change in cost of production \( Q_1AE_1Q_2 \). As long as input prices remain constant the danger of the type of aggregation bias so far outlined is non-existent.
No doubt, in many instances, the assumption of a perfectly elastic curve is justified. However, the good (cautious?) benefit-cost analyst would always have his weather-eye open in anticipation of the possibility of the sort of bias outlined. It would seem that the probability of such bias could be greater, the greater the impact of the developmental scheme on the supply curve; that is, it would depend on the significance of the change in output in relation to total national output.

An example of a failure to recognize the importance of aggregate market effects is provided by the assessment of the Brigalow scheme in Australia (4) where it was not appreciated that the magnitude of the scheme would lead to considerable difficulty in obtaining store stock for fattening purposes. This was an instance of a failure to anticipate the probable nature of an input supply curve to the industry with its subsequent implications for farm development, organization and producer's surpluses.

The fundamental significance of the foregoing is its demonstration of the potential importance of consumers' surplus. Prest and Turvey (10, p.691) emphasize this and go further by pointing out that the gross benefit of a project which includes products which are inputs to processes outside the project is "... measured by the market value of sales plus any increase in consumers' and producers' surplus in respect of any final product based on the intermediate ones". Kelso (6, p.30) develops this point in some detail and it is apparent that whenever perfectly inelastic or elastic demand curves cannot justifiably be assumed the benefit-cost analyst's task becomes far more complicated, with the degree of complexity depending on the parameters of the curves. A further possible complication is that net off-project changes in producer or consumer surpluses should be credited to the project as admissible secondary benefits.

In the New Zealand situation a lot of thought should be given to the possibility of such market effects occurring and their potential nature. This is so because so much of the literature on benefit-cost analysis is written within the context of a large country, particularly the United States, where it is implicitly assumed that most projects involve marginal changes in production and consumption only. New Zealanders cannot afford to make this assumption as casually. In New Zealand the position is also complicated in that many of the commodities effected by projects are sold on both export and import markets through relatively complex marketing schemes.

The Measurement Problem in Aggregation

To this point we have been discussing the dangers of "wrong" answers in the benefit-cost studies when projects produce outputs or demand inputs to an extent which affects prices. We will now turn to the second of our problems, which is a measurement one arising from
the fact that most agricultural project evaluations are concerned with assessing the aggregate effect of the behaviour of many firms.

If we make the, in my view, heroic assumption that our predictions of individual firm behaviour are no reason for concern, we can concentrate our attention on the question of the performance of agricultural economists in predicting the aggregate results of the behaviour of many farm firms.

There are two main ways in which such problems are usually tackled:

(a) Aggregation of representative farm studies; and
(b) the use of interregional competition models to estimate spatial equilibrium.

While considerable experience has been had with both methods, all too seldom have tests been made to validate particular models by endeavouring to reproduce a real world situation. The few tests which have been made have had depressing results.

(a) The Representative Farm Approach

This procedure consists of constructing a linear programming model of a farm firm which is "representative" of some defined population. The coefficients of this model are obtained as averages of those of a sample of farms taken from the population. The principle behind the procedure is, having derived the optimum plan for the representative farm, to derive the corresponding estimate for the population by multiplying that optimum plan by the number of farms in the population.

Of course, this is a simplified statement of the problem and, in particular, modifications to the sampling procedure may be introduced to improve the "representativeness" of the case farms. The effect of policy changes, such as the impact of public investment decisions, can be incorporated in the farm firm models.

The most dramatic test of this procedure for aggregation bias has been that of Frick and Andrews (5). They took a "population" of 51 farms and used linear programming to derive normative supply functions for each farm. They then summed the results over all farms to obtain what was assumed to be the "true" population supply relationship. They then grouped the farms according to size and resource mix and selected a representative farm from each group. Normative supply functions were developed for each representative farm, the results were aggregated back to the groups and the group supply functions were weighted and summed to obtain population supply functions for each sampling procedures. All of them were biased in relation to the true relationship, some considerably more seriously than others.

Since this work was done there has been continued study of the problem but, unfortunately, the problem of aggregation bias remains with
us and there is little doubt that it could be a very serious source of error in some studies. An unpleasant aspect of the problem is that we, as yet, do not know how serious the bias will be in different situations, although, as would be expected, one would anticipate less bias with homogeneous populations than with heterogeneous ones.

There is some glimmer of hope. Lee (7) following some pioneering work by Miller (9), has developed conditions for bias-free aggregation. Unfortunately, his conditions, while not being outrageously restrictive, are still, at the moment, unrealistic because the criteria for their application can only be developed in the two-input case. However, we can afford to be optimistic, if only because Lee's conditions are a considerable advance on the suggestion by Day (2) that bias could only be avoided by grouping farms lying on the same scale line of a homogeneous production function of degree one. This was an impossible requirement.

Work is proceeding on a generalization of the Miller-Lee conditions.

(b) The Use of Interregional Competition Models

If one were to turn, then, in disgust from the representative farm approach, one could exercise the multiple firm demon by treating the area for development as a monolithic unit. This is what happens when interregional competition or spatial models are used.

The study of interregional competition represents a rapidly growing and challenging area in the general field of agricultural economics. The models and approaches which have been developed in the last ten years are legion (8) and the rate of improvement in the methodology is so rapid that one should not be over- impressed by any shortcoming in a particular model at any particular point in time, for it may soon be overcome.

In general spatial models consist of the specification in a mathematical programme of commodity supply and demand functions for each of the several regions into which the area of interest is divided. The general class of spatial model is divided into two sub-classes, one being the equilibrium models in which explicit supply functions are used, and the other being the activity analysis models in which the supply functions are implicit. In the latter case commodity production processes are explicitly defined. It seems likely that developmental proposals would be best studied by means of activity analysis models with the effect of development being reflected in the coefficients of the appropriate production processes.

Most studies of policy (including resource development) using spatial models have been based on the use of linear programming. Such models are rather limited in scope because they can only be used
satisfactorily with the assumption of either perfectly elastic or perfectly inelastic demand and supply schedules. While adaptations can be made to meet price responsiveness to quantities demanded or supplied, for example by using iterative procedures (11), such possibilities are usually limited in scope.

Formal procedures for analysing problems where regional demand and supply curves are neither horizontal nor vertical are available. These techniques maximize "net social payoff" which is, in effect, the sum of producers' and consumers' surpluses. However, as they require data in a relatively highly refined form, and as they are based on non-linear programming procedures and therefore impose high demands on computer space, the potential for the use of these procedures does, at the moment, seem limited.

Despite this, the prospects for these non-linear programming interregional models are promising, particularly with increasing computer size. Many important conceptual problems have been solved in relation to the development of a generalized and flexible interregional, intertemporal model (12).

However, we are not there yet!

One must be critical of those who have developed and used spatial models for their more or less general failure to validate them. Several years ago Baker (1) commented on some of the tests on spatial models which had been carried out to that time and had to express disappointment with the results. A few other tests have been conducted since then, but few have been published (13 is one of the few). Of these, the results have been as disappointing as those discussed by Baker. It is unfortunate that no published tests have been made of the more sophisticated models developed since Baker made his remarks, but it is my belief that the biases involved are so serious that I would be surprised if they were to perform all that much better than did the earlier models.

It seems to me that, except for those models which are constrained to "behave" themselves (13) or for those which fall into the recursive class (3), interregional programming models must remain suspect as a means for predicting the effect of policy changes.

Conclusions

It would appear that our ability to predict accurately and confidently the aggregate effect of the behaviour of farm firms is highly suspect. This means that our studies of large scale land development and settlement schemes must tend to be empirically and conceptually crude at the aggregate level. This, in turn, implies that the returns to continued refinement of individual or representative firm models may decline at a rapid rate until the problems of aggregation are reduced or, at least, better understood.
BIBLIOGRAPHY


CHARACTERISTICS OF THE INVESTMENT PROCESS

R. C. Jensen
Lincoln College

Investment evaluation enters, to a greater or lesser extent, into several specialised fields. The accountant, executive, farm management specialist, management consultant, valuer, the economist, and some other specialised workers, all consider that investment evaluation in some form or other, as part of their professional equipment. To those outside these categories whose training has not included the elements of investment evaluation, it often appears as a difficult and complicated technique. In fact the techniques are basically very simple.

A great deal of theoretical discussion of investment evaluation continues in professional journals. Most of this discussion is directed to the interpretation of measures of value, rather than to the techniques per se. Competence of the use of investment analysis depends not only in the calculation of measures of value, but in the interpretation of the results, and in realising the limitations of the technique.

This paper is basically "theoretical" in nature, and attempts to present the simple truths of investment evaluation. No attempt is made to provide "practical" information - this will be developed later in the symposium.

The following topics are considered:

1. Scale of Investment
2. Timing of Investment
3. Rate of Investment (both constant and varying)
4. Effect of Discount Rate
5. Effect of Time Period of Analysis
6. Class of Investment
7. The V/C Ratio, and Optimisation.

* I am indebted to Mr R.W.M. Johnson and Mr A.T.G. McArthur for their comments on this paper. Certain sections of this paper, in particular that dealing with the Rate of Investment, are a result of a confluence of ideas from Mr A.T.G. McArthur, Mr N.G. Gow, Mr G.R.J. Cleland and the author. Separate research works proceeding independently have developed similar approaches to this topic. In particular Mr McArthur has contributed a great deal in the use of unit cash flows and rate of investment studies.
Scale of Investment

If an investor has the choice of buying one or more machines, each of which gives rise to the same cash flows, then the net present value (NPV) of an investment is directly dependent on the number he buys, and the internal rate of return (IRR) is constant.

E.g., a machine (or other class of investment) whose purchase gives rise to the following net cash flows:

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>($)</td>
<td>40</td>
<td>9,1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

From this flow, NPV at 5% = £6.8
IRR = 6%

The purchase of two or more machines would give net cash flows of:-

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>($)</td>
<td>80</td>
<td>18,2</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

NPV = $13.6 IRR = 6%

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>($)</td>
<td>120</td>
<td>27,3</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

NPV = $20.4 IRR = 6%

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>($)</td>
<td>40x</td>
<td>9.1x</td>
<td>2x</td>
<td>2x</td>
</tr>
</tbody>
</table>

NPV = $6.8x IRR = 6%

These relationships would not depend on the time period involved, provided it does not change, but on the symmetry of cash flows. In this case the cash flows appear as in Figure 1.

---

1 Assuming away diminishing returns for illustrative purposes.
These relationships can be shown simply in mathematical terms:

$$\text{NPV}_1 \text{ machine} = \sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}$$
where $j = 1 \ldots n$

$b_j$ and $c_j$ = expected receipts and payments
and $b_j - c_j$ are the net cash flows.

$$\text{NPV}_2 \text{ machines} = \sum_{j=1}^{n} \frac{2(b_j - c_j)}{(1+i)^j} = 2\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}$$

$$\text{NPV} \times \text{ machines} = \sum_{j=1}^{n} \frac{x(b_j - c_j)}{(1+i)^j} = x\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}$$

and, if $\text{NPV} = 0$, then

$$\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j} = 0 \text{ at } r$$

clearly

$$2\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j} \text{ and } x\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j} = 0 \text{ at same } r.$$
Rate of Investment

The rate of investment may be defined simply as the number of units of investment applied in any time period. This can be expressed in money values (e.g., $100 per year) or in physical terms (e.g., 5 ewe equivalents per year). The rate of investment may be constant as it would be in the case of a farmer increasing stocking rate by 0.5 ewe equivalents per year. It may vary from year to year, as it would if a farmer were investing annually a fixed proportion of a fluctuating income.

Constant Rate of Investment

If the rate of investment is constant over time, i.e., the distribution of investment is even, then again the NPV of the investment depends directly on the rate of investment, and the IRR is constant.

E.g., the unit of investment is 1 ewe equivalent with a net cash flow of: -6, -4, 2, 3, 3, 3, ... inf.

If the rate of investment is one ewe equivalent per year for four years, the following cash flows will be generated.

Table 2

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>-6</td>
<td>-4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3... to inf.</td>
</tr>
<tr>
<td>$</td>
<td>-6</td>
<td>-4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3... to inf.</td>
</tr>
<tr>
<td>$</td>
<td>-6</td>
<td>-4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3... to inf.</td>
</tr>
<tr>
<td>$</td>
<td>-6</td>
<td>-4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3... to inf.</td>
</tr>
<tr>
<td>Total Net Cash Flows:</td>
<td>$</td>
<td>-6</td>
<td>-10</td>
<td>-8</td>
<td>-5</td>
<td>-4</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

NPV at 6% = $126.5
IRR = 24.4%

If the rate of investment in physical terms is higher, the net cash flows would be as listed below in Table 3 and shown in Figure 2.

Table 3

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 e.e.$</td>
<td>-30</td>
<td>-50</td>
<td>-40</td>
<td>-25</td>
<td>20</td>
<td>55</td>
<td>60</td>
<td>60... to inf.</td>
</tr>
<tr>
<td>10 e.e.$</td>
<td>-60</td>
<td>-100</td>
<td>-80</td>
<td>-50</td>
<td>40</td>
<td>110</td>
<td>120</td>
<td>120... to inf.</td>
</tr>
<tr>
<td>15 e.e.$</td>
<td>-90</td>
<td>-150</td>
<td>120</td>
<td>-75</td>
<td>60</td>
<td>165</td>
<td>180</td>
<td>180... to inf.</td>
</tr>
<tr>
<td>x e.e.$</td>
<td>-6x</td>
<td>-10x</td>
<td>-8x</td>
<td>-5x</td>
<td>4x</td>
<td>11x</td>
<td>12x</td>
<td>12x... to inf.</td>
</tr>
</tbody>
</table>
Net Cash Flows

IRR = 24.6%
for all rates

Pv @ 6%

15 e.e.  
(15x$26.5  
= $2897)

$  
(10x$26.5  
= $1265)

$  
(5x$26.5  
= $633)

$126.5

Fig. 2
Footnote to Table 3

5 ewes - NPV at 6% = $632.5  IRR = 24.4%
10 ewes - NPV at 6% = $1265.0  IRR = 24.4%
15 ewes - NPV at 6% = $1897.5  IRR = 24.4%
x ewes - NPV at 6% = $126.5x  IRR = 24.4%

Again, the relationships between the NPV's and the IRR's of the various rates of development depend, not on the length of the time period involved, but on the proportional relationships between the different cash flows.

In general mathematical terms, let

\[ f_j \]

represent the number of units of investment applied in each year \( j \) \( \ldots n \);

\[ V_j \]

represent the present value of the unit of investment in the year in which it is applied, then:

\[
\text{NPV}_N \text{ units} = \frac{f_1 V_1}{(1+i)} + \frac{f_2 V_2}{(1+i)^2} + \cdots + \frac{f_n V_n}{(1+i)^n}, \text{ where } f_1 = f_2 = \ldots = f_n, f_1 = N
\]

\[
= \sum_{j=1}^{n} \frac{f_j V_j}{(1+i)^j}
\]

\[
\text{NPV}_{2N} \text{ units} = \frac{2f_1 V_1}{(1+i)} + \frac{2f_2 V_2}{(1+i)^2} + \cdots + \frac{2f_n V_n}{(1+i)^n}
\]

\[
= 2 \sum_{j=1}^{n} \frac{f_j V_j}{(1+i)^j}
\]

i.e., the NPV of a strategy will depend directly on the rate of development. It is clear that IRR will be independent of the rate of development.

Varying Rate of Investment - Distribution

In practice, investment is made in an uneven or possibly a lumpy fashion, depending on the availability of investment capital, personal preferences and expectations, etc. Seldom, if ever, is the rate of investment constant over time. The distribution of investment is
defined here to measure the relative concentration of investment in the earlier or later years of a time period. This is demonstrated by an example in Appendix I, and will not be detailed here.

It has been shown so far, both empirically and in simple theoretical terms, that for a particular class of investment,

(a) there is a direct relationship between scale of investment and net present value;

(b) the relationship between net present value and time of investment is a factor of \(\frac{1}{1 + \frac{1}{i}}\);

(c) there is a direct relationship between rate of investment and net present value;

(d) that IRR is independent of scale, timing or rate of investment.

The distribution of investment is clearly a combination of rate, timing, and scale of investment. Consequently we can expect that, while IRR will not be affected by changing distributions of investment, NPV will be substantially affected. Briefly, as shown in Appendix I, the NPV of an investment will be higher with earlier investment and a higher rate of investment, i.e., investment should be made as early and heavily as budgetary or technical constraints allow.

The Effect of Discount Rate

\[
NPV = \sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}
\]

where \(i = \) discount rate

and

\[
\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j} = 0 \text{ when } i = \text{IRR}
\]

and taking as an example, an investment generating a series of cash flows of $-30, -50, -40, -25, 20, 55, 60, 60 ... inf., Figure 3 shows this series of cash flows with each annual flow discounted at various rates. For example in year 6, the net cash flow is $55; discounted at 10, 20 and 25 per cent, the discounted values are respectively $31, $18.4, and $14.4.

As the discount rate increases the curves representing the discounted value become flatter, and the area C (representing positive values) comes closer in area to area B (representing negative values). Since Area C less Area B represents NPV, then NPV will be decreasing as the discount rate increases. This is shown on Figure 4 for the
Figure 3
same series of cash flows. The discount rate at which Area B = Area C, i.e., NPV = 0 is the IRR. In this example, IRR is relatively high, if however the IRR was closer to a commonly used discount rate, an error in the choice of discount rate could make desirable projects appear undesirable and vice versa.

**Effect of Time Period of Analysis**

A later paper by Mr. G.R.J. Cleland will discuss this aspect. It is sufficient to mention at this stage that adequate technical knowledge regarding the life of an investment is essential to avoid the possibility of distorted results. In any case the time period of analysis should be long enough to define a stable or equilibrium post-investment situation.

**Class of Investment**

Class of investment is defined here as the activity, or process to which investment is applied. Specifically, production units which have differing capacity or output are different classes of investment, and would generate differing streams of cash flows. Differing environmental conditions could throw off quite different series of cash flows.

As an example, take classes of investment (e.g. machines) with different cash flows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Cash Flows - Years</th>
<th>NPV at 5%</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1 2 3 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class A ($)</td>
<td>40 9.1 2 2 inf.</td>
<td>6.8</td>
<td>6%</td>
</tr>
<tr>
<td>Class B ($)</td>
<td>40 9.1 3 3 inf.</td>
<td>24.6</td>
<td>8.7%</td>
</tr>
<tr>
<td>Class C ($)</td>
<td>40 -10.5 3 3 inf.</td>
<td>6.8</td>
<td>5.8%</td>
</tr>
<tr>
<td>Class D ($)</td>
<td>40 - 7.6 3 3 inf.</td>
<td>9.4</td>
<td>6%</td>
</tr>
</tbody>
</table>

Class A investments are not as "efficient" as are B investments which can earn a higher cash flow from year 3 onwards. Each unit of class B investment would have a higher NPV and a higher IRR than units of class A. Class A investments have the same NPV at a discount rate of 5% as class C investments, but show a higher IRR. On the other hand, class D investments show the same IRR as class A investments, but have a higher NPV. An area of confusion can exist when one measure of profitability is used to the exclusion of others. The problem of the selection of projects, and the criteria used will be outlined by Mr. Johnson in another paper but it is important at this stage to demonstrate some relationships between NPV and IRR.

These relationships, as suggested in Table 4 above, will depend on the size and sequence of the cash flows associated with the various class of investment, and on the discount rate.
Figure 4 showed the relationship between NPV and discount rate for a particular stream of cash flows. The various graphs of Figure 5 show the same for hypothetical streams of cash flows generated by various classes of investments.

Figure 5(a) shows quite simply how two classes of investment (G and H) with different streams of cash flows may have the same IRR (in this case 6%) but differing NPV's at a given discount rate (e.g. 5%). In this case, at a discount rate of 5 per cent, NPV_h > NPV. This example parallels investments D and A above. Figure 5(b) demonstrates simply the position where NPV curves intersect. Investment E has a higher IRR (7%) than investment F (5%). Comparison of NPV's varies with the discount rate used. At a discount of 3.7%, NPV_E = NPV, paralleling investment classes A and C. At discount rates greater than 3.7%, NPV_f > NPV, and investment E appears the most attractive. At discount rates less than 3.7%, NPV_f > NPV, and investment F could appear the most attractive proposition.

Two important points emerge: first IRR, while dependent on the size and sequence of cash flows may not be a useful guide to the relative attractiveness, unless we know that the NPV curves do not intersect (e.g. investments I and J in Figure 5(c)). This we normally do not know. Second, a small change in the discount rate used to calculate NPV, (e.g., 3.7% - 3.1% in Figure 5(b)) could reverse the order of attractiveness where NPV is the criterion used. Since NPV is normally not calculated over a wide range of discount rates, we seldom know the relationship between NPV curves.1

Other possibilities, less common, exist. The PV curves could intersect twice. For example, Figure 5(d), NPV_k = NPV_l at two interest rates, corresponding with p_1 and p_2, and the IRR's of the two investments may be different. Lastly, it is quite possible that no unique IRR can be found. If the NPV curve, due to heavy investment late in the time period, becomes negative, then positive and so on, the situation could be as represented in Figure 5(e) for investment M. Theoretically, three IRR's exist, in this case 3, 4, and 6 per cent. More advanced techniques may be required to obtain an appropriate solution rate of interest. As mentioned previously, the decomposition of aggregate cash flows to unit cash flows to obtain the IRR associated with the investment unit may overcome this problem in many cases. It would be necessary however that the unit cash flows did not exhibit multiple IRR's, and that the unit cash flows, when obtained, are acceptable on theoretical grounds.2

1 Mr G.R.J. Cleland has written a programme for the IBM 1130 Computer which would provide this information over a range of discount rates from 1-100 per cent.

2 The derivation of unit cash flows from aggregate net cash flows was first demonstrated I believe by A.T.G. McArthur, Lincoln College, (Agricultural Economics Paper No. 410).
Fig. 5(a)

Fig. 5(b)
Fig. 5(e)
The recognition of different classes, rates and distributions of investment in project evaluation is important when comparison of alternative investments are to be made. The "shape" of a stream of cash flows arising from an investment will depend on

(a) the rate of investment
(b) the timing of investment
c) the class of investment

Strictly speaking, if two classes of investment are to be compared, then "all other things (timing and rate) should be equal", otherwise a confounding situation occurs. It is not sufficient, for example, to compare investment in dairy cattle and beef cattle to increase stocking rates on a farm, unless the rate and timing of investment is the same for both types of stock.

The V/C Ratio

It will be remembered that NPV can be calculated in either of two ways:

(a) discounting the returns or income stream \((b_j)\),
(b) discounting the cost stream \((c_j)\) and finding:

\[
P_{b_j} - P_{c_j} = \sum_{j=1}^{n} \frac{b_j}{(1+i)^j} - \sum_{j=1}^{n} \frac{c_j}{(1+i)^j} = \sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}
\]

(b) determining net cash flows \((b_j - c_j)\) for each time period and finding:

\[
\sum_{j=1}^{n} \frac{(b_j - c_j)}{(1+i)^j}
\]

It can be shown simply that under some conditions, the V/C ratio may be confused if method (b) above is used.

Taking as an example the following stream of cash flows:

<table>
<thead>
<tr>
<th>Table 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>Returns ((b_j)) (($))</td>
</tr>
<tr>
<td>Costs ((c_j)) (($))</td>
</tr>
<tr>
<td>Net Cash Flow ((b_j - c_j)) (($))</td>
</tr>
</tbody>
</table>
It is important to distinguish between "returns" or "income" and "positive cash flows", and "costs" and "negative cash flows". Table 5 shows actual costs and returns which could generate net cash flows of -6, -4, 2, 3, 3. The actual returns are shown in the b row and the costs in c row. Some workers using discounting techniques have yielded to the temptation to designate the negative net cash flows as costs and the positive net flows as returns. The following calculations show how an erroneous V/C ratio can be calculated when "costs" are not correctly defined.

Using method (a)

\[
PV_b = \sum_{j=1}^{n} b_j \frac{1}{(1+i)^j} = \$61.11 = V
\]

\[
PV_c = \sum_{j=1}^{n} c_j \frac{1}{(1+i)^j} = \$26.67 = C
\]

NPV (or V-C) = $34.44  IRR = 24.4%  V/C = 2.29 (correct)

Using method (b)

PV of positive cash flows = $43.66
PV of negative cash flows = $9.22
NPV = $34.44  IRR = 24.4%  V/C = 4.74  (erroneous)

Studies which do not specify actual costs and merge costs and returns into aggregate net flows will clearly be unsuitable for calculation of V/C.

The V/C ratio measures the return or benefit per unit of cost, or investment. A simple modification of this ratio, namely \( \frac{V-C}{C} \) or \( V \) \( C-1 \) will measure net benefit or net return per unit of investment in a discounted sense. Clearly V/C and \( V \) \( C-1 \) will vary together for any investment. Hence, we have a measure (expressed as a ratio) of "returns per dollar of outlay" (V/C) or "net returns per dollar of outlay" (\( V/C - 1 \)).

Several variations of the V/C ratio exist. The Bureau of
Agricultural Economics\textsuperscript{3} suggests "dynamic" benefit/cost ratios which are calculated to include establishment and operating costs, and "static" benefit/cost ratios when all estimates of income, capital and costs are related to the full development period. Quite clearly, any number of variations of the \( \frac{V}{C} \) ratio can be calculated to some specific purposes, according to the information required. Some of these ratios appear to have a promising potential in project selection procedures. Mr McArthur\textsuperscript{4} has used a ratio \( \frac{V-C}{C'} \), where \( C' \) represents the negative cash flows in the series of cash flows arising from an investment, and suggests its use in selection procedures. Mr Johnson will discuss this in detail in a following paper.

The relationship between \( V-C \) and \( \frac{V}{C} \) is shown in Figure 6 in relation to establishing the optimum scale of investment. We could assume that the proposed investment is a reservoir for irrigation and power generation, and that as the size of the proposed reservoir increases, diminishing returns are encountered.

Three points in Figure 6 are significant.

**Point 1** - The size of the investment at which \( \frac{V}{C} \) is a maximum (i.e., \( BB' \) has the greatest slope, and the \( \frac{V}{C} \) curve in the lower graph is a maximum).

**Point 2** - The size of the investment at which \( V \) exceeds \( C \) by the greatest amount, i.e., \( V - C \) is a maximum. At this point the cost of adding the last increment of size \( \Delta C \) is equal to the added benefits \( \Delta V \) resulting from that increment, i.e., \( \Delta V = \Delta C \) and \( \frac{\Delta V}{\Delta C} = 1 \). Investment beyond this point would require additional expenditure in excess of additional benefits and would not be justified.

**Point 3** - \( V = C \), and \( \frac{V}{C} = 1 \). Between points 2 and 3, although \( \frac{V}{C} \) is greater than one, the additional benefits are less than the additional costs.

Net benefits are maximised when the size of the investment is extended to the point where the benefits added by the last increment of scale are equal to the costs of adding that increment. This will occur at point 2.

\textsuperscript{3} The Economics of Bigalow Land Development in the Fitzroy Basin, Queensland, Bureau of Agricultural Economics, 1963.

\textsuperscript{4} Personal communication.
Figure 6:
Figure 6 demonstrates some important points.

(a) That maximising $V/C$ will not lead to the optimum level of investment. In the point-input, continuous output case, IRR is maximised when $V/C$ is maximised, so that maximising the IRR will similarly not lead to optimum scale of investment.

(b) That increasing investment until $V/C = 1$ is similarly irrational.

(c) That an attempt should be made to invest as close to point 2 as possible.

**APPENDIX I**

**AN EMPIRICAL EXAMPLE DEMONSTRATING DIFFERENT DISTRIBUTIONS OF INVESTMENT**

Suppose technological limitations place an upper limit on the capital intensity of a project. Our example will be a farmer who can increase the number of ewe equivalents on his farm by 150, over a period of 15 years. He can invest in ewes at different rates at different times of the fifteen year period. As an empirical exercise, 9 alternative strategies have been considered, (Table 6 and Figure 7.) The net cash flow associated with each ewe is assumed as $-6, -4, 2, 3, 3, \ldots$ to inf.

It is necessary to have some measure of the degree of asymmetry, or departure from the symmetry of the constant level of investment. An obvious measure is one related to skewness.

Conventional measures of skewness, such as the third moment about the mean of a distribution are not suitable. We must consider the range of the distribution arbitrarily to be a definite period of time – in this case 15 years, since we must have a basis of comparison of "skewness" for all 9 distributions of investment. An index in dimensionless form, based on the suggestion of G.R.J. Cleland was developed:

$$\kappa = \frac{f(d^1)^3}{N}$$

where $f = \text{no. of units of investment in any year}$

$d^1 = \text{mid point of time scale (i.e. = 8 in example)}$

$\kappa = \text{deviation from } d^1$

$N = \text{number of units of investment (i.e. = 150 in example)}$. 
Figure 7: Distributions of Investment used in Empirical Example
The index varies only between +1.0 and -1.0. Calculated values for the 9 strategies considered in the empirical example are shown in Table 6 and Figure 7.

The cash flows generated by each investment strategy, with NPV's and IRR's all shown in Table 7. It will be immediately apparent that those strategies where investment is concentrated in the earlier years exhibit higher NPV's, i.e. C, E, G & A, and further that the more concentrated the investment in the earlier years (i.e. the higher the $\alpha$ index) the higher the NPV. The relationship between $\alpha$ and NPV is shown in Figure 8.

Since several distributions of investment could provide the same value for $\alpha$, it is not possible to state an exact mathematical relationship between NPV and $\alpha$. All that can be noted is that NPV obviously decreases as the distribution of investment becomes less positively "skewed", i.e. as $\alpha$ decreases. In fact, the NPV of the same total investment falls by over 55% as $\alpha$ moves from +1.0 to -1.0. Intuitively, it would appear that, since the points on Figure 8 are not unique for any value of $\alpha$, the relationship between NPV and $\alpha$ could be expressed by a curve represented by an area such as that between the dotted lines on Figure 8. The width of this area would depend on the range of distributions of investment which satisfy any value of $\alpha$.

The message from Figure 8 is that the distribution of investment should be as positively "skewed" as budgetary constraints allow, i.e. investment should be made as early and heavily as possible. It is clear also that IRR is independent of distribution of investment.
Figure 8: Relationship of PV of Investment Strategies used in Empirical Example to Value OC.
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Table 7

Net Cash Flows, NPV's & IRR's associated with Investment Strategies

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<th>C</th>
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NPV 18 yrs. 1738
NPV to inf. 4361
IRR% 24.4
UNCERTAINTY AND ITS EFFECT ON CAPITAL INVESTMENT ANALYSIS

G. R. J. Cleland
Department of Agriculture

This paper is concerned with the usefulness of "theoretically correct" choice indicators in real world investment decisions.

For the purposes of this paper "theoretically correct" measures are taken to be the Present Value, and the Internal Rate of Return of a stream of cash flows.

The measures of profitability most often used, by business men such as "Pay Back Period", or "Simple Return on Capital", have been criticised by economists as unscientific. However we must be sure that the theoretically correct measures do give better results than the unsophisticated decision rules.

It can be shown that when all costs, returns, project lives, and salvage values, can be accurately predicted, the theoretically correct measures do give a better indication of profitability than the unscientific measures. However, all capital investment does involve some measure of uncertainty. It is the aim of this paper to show that because of this uncertainty the value of the theoretically correct measures may be limited, and that an appreciation of the limits of the techniques is necessary.

First we will show diagrammatically the effects of uncertainty, length of project life and annual return, and then go on to measure these effects for specific examples.

First consider the simple case of single investment, yielding a constant annual return, for a fixed period.

---

1 This paper leans heavily on "Uncertainty and Its Effect on Capital Investment Analysis", Martin B. Solomon Jr. Journal of Management Science, Vol. 12, No. 8, April 1966.
In its undiscounted form it may be represented thus:

\[ \text{Annual Cash Flow} \]

When this is discounted \( \frac{a_i}{(1+r)^i} \) it may be represented:
Present value of the stream of discounted cash flows is equal to the area above the zero axis, minus the area below the axis.

Hence it can be seen that the change in present value which results from a change in the length of life of a project may be represented by the addition, or subtraction of one "block" from the right hand end of the diagram.

It will be apparent that an error of one year in the estimation of project life in a project of long life will cause a relatively small error in Present Value, while an error of one year in a project of short life will cause a relatively large error.

Errors in the estimation of annual return: For simplicity we will assume a constant under-estimation error in the estimation of the annual return. This is represented in its undiscounted form thus:-
and in its discounted form:

\[ \text{P.V.} \]

\[ \text{\$} \]

\[ \text{yrs.} \]

It will be seen that change in present value will depend directly on the change in annual return, but the absolute value of the change in Present Value will be greater for a project with a longer life.

Although the above conclusions are stated in terms of present value, similar conclusions follow for our alternative "theoretically correct" measure, Internal Rate of Return.

Now let us consider a numerical example. For simplicity, we will take a single investment of \$10,000, with a uniform annual return (which we shall vary), for a number of years which we shall also vary.

The attached table and Graph I, showing the Internal Rate of Return, for each combination of annual return and project life, were calculated on the computer. The table may be useful for calculation of Internal Rate of Return, when working with uniform series, as using conventional tables, internal rate of return often involves tedious calculation.

Looking at the table of Internal Rates of Return, as this is easier to visualise than Present Value, we notice that Internal Rate of Return does vary quite rapidly as we change the value of the parameters.
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For instance, let us assume that the estimated return is $1,500 per annum, and the expected project life is 10 years. We see that the IRR is 8.1%. If we are using an interest rate of 6%, this scheme is *prima facie* profitable. But if the project life should drop to 8 years, the IRR will fall to 4.2%—*prima facie* unprofitable. However it will also be seen that the IRR for the same cash flows at 24 years, and 30 years, are 14.4% and 14.7% respectively. Hence the conclusion is that while IRR is unstable with respect to project life at short project lives, say less than 10 years, it is quite stable at long project lives.

Now we will examine the effect of variation of annual return.

Let us assume that the project is to have a life of 10 years, and an estimated return of $1,500 per year. From the table the IRR is 8.1%. However if the return in fact turns out to be only $1,300 per year, the IRR drops to 5%.

If we are told a project has a life of 9 years, plus or minus one year, and an annual return of $1,400 plus or minus $100, all we can say is that the internal rate of return lies between 1% and 8%. Clearly IRR is so unstable as to be of limited value.

If we define the error in the annual return in terms of the original investment, in this case $10,000, an error of $100 is a 1% error. Hence a 1% error in annual return for a short project life, looking down the columns of the table, causes an error of 1.5 percentage points in the IRR, while a 1% error in annual returns causes an error of 1.1 percentage points at long project life.

Because these errors in project life and annual returns are by no means unlikely, one has to be cautious with the theoretically correct measures.

Thus if two proposals are nearly equally profitable, there will not be a significant difference between the projects' internal rates of return, while, if one of the proposals is obviously more profitable than the other, simple measures such as pay-back-period or return on capital, could provide the same information as the theoretically correct measures, at less cost.

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1 The difference between 6% and 7% is said to be 1 percentage point.
An interesting feature of the above analysis is that the relationship between annual return, and internal rate of return is close to linear, and constant over the whole range. On the other hand, the relationship between internal rate of return and project life is not constant but curvilinear. Hence proposals that last less than the estimated life, lower the average internal rate of return, more than proposals that last longer than the estimated life, raise it. Thus errors in annual return may average out over a large number of investments, but errors in project life will not average out. In fact even small errors in project life will result in a serious over-statement of profitability.

To make the analysis more complete the situation of non uniform annual returns should be discussed. In all cases the tables and diagrams are very similar to those given above, and all the conclusions still hold. Let us now look at the effect of taxation.

Because most of the cost-benefit studies are done at a national level, taxation has not been included in the calculations as taxation is only a transfer payment, and does not represent the using up of factors of production. However, from an individual's point of view, taxation must be taken into account in measuring profitability.

Because taxation is progressive it will, to a small extent, tend to buffer the effect of changes in annual return, and project life. Where annual return is under-estimated, taxation will also be under-estimated, and the two will partially offset each other, so that the final error in Internal Rate of Return of post-tax income is smaller than the error in Internal Rate of Return in pre-tax income. However it is likely that this effect will be small, and because taxation will bring the project nearer to the boundary between profitable and unprofitable, the smaller error may still be critical.

For instance, let us consider a project of 20 years, straight line depreciation, and a taxation rate of 50c. in the dollar. If the possible pre-tax returns are $2,700 and $2,900, the internal rates of return will be 26.7%, and 28.8% respectively. But the post-tax internal rates of return will be 9.0% and 10.3% respectively. The absolute difference has been reduced, but the difference is now even more critical.

Similarly, let us take a stream of incomes of $3,000 per year and using a depreciation rate of 10% of depreciated value, and a 50c. in the dollar taxation rate, allow project life to vary between 8 and 10 years.

Pre-tax IRR's are 24.9% and 27.3% respectively.
Post-tax IRR's are 12.5% and 14.5% respectively.
Summary

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<td>$2,700</td>
<td>26.7%</td>
<td>9.0%</td>
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<td>8 yrs.</td>
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<td>$3,000</td>
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All the above conclusions have been stated in terms of Internal Rate of Return, because this is easier to visualise than Present Value.

However, as will be seen from Graph II, any conclusions which apply to IRR also apply to Present Value, as Present Value is a simple increasing function of IRR.

The greater the IRR, the greater the Present Value for the example considered.

As will be seen when project life is constant and variations in annual return are being considered, Present Value is almost a linear function of IRR.

Conclusion:

The theoretically correct measures, Internal Rate of Return and Present Value, are so unstable with respect to the annual return of a project, and to the project life, that simple measures such as pay-back-period, which do allow for obsolescence, technological change, and uncertainty of the future, may be just as useful in real world investment decisions.
Relationship Between Present Value of a Uniform Series and Internal Rate of Return

- Constant Annual Return ($2000) with Variable Project Life
- Constant Project Life (10 yrs) with Variable Annual Return.
THE SELECTION OF PROJECTS

R. W. M. Johnson
(Lincoln College)

In this paper, I want to discuss the selection of projects by the net present worth method, and to note cases where a different criteria should be used. There are three basic criteria in use: net present worth \( (V-C) \), ratio of present worth of benefits to present worth of costs \( (\% \) ), and the internal rate of return, or solving rate of interest \( (\text{IRR}) \). These measures can give widely different priorities if definitions of costs and benefits are not uniform, so part of this paper is concerned with definitions and part with the respective criteria to use.

The main purpose of this paper is to identify the situations where projects have to reach some minimum level of profitability and those situations where the "best" schemes have to be identified. In economics, we would say that if an unlimited supply of funds were available for investment, then all schemes which reach the stated minimum would qualify and be carried out. When funds are limited, for whatever purpose, we talk of "capital rationing", and this involves choosing projects that contribute most to desired objectives. At first sight it might appear that this distinction would cause no difficulties; we see below just what the difficulties are.

It is useful to make the usual distinction at this stage between the national interest and the individual interest. In economics, we talk of net social present worth where the national interest is concerned, and net private present worth where an individual or business decision was involved. The distinction also applies to the definition of costs and benefits. Social costs and benefits are usually aggregates of the private and public part of schemes; e.g. government investment in irrigation structures like border dykes and so on. The two are combined to establish whether it is in the national interest to support the scheme. Whether the irrigation farmers should accept the scheme for their part requires analysis of net private present worth, e.g. what will they get out of it in terms of increased personal income, capital appreciation and the like.
A further useful illustration is that social benefits can be reckoned but not collected. The added income in the community is dispersed and can only be "collected" in the form of levies, rates or taxes. Private benefits are more measurable because they can be counted in cash terms, and trading accounts will already show the necessary totals.

The term net present worth is used because the decision usually involves the capital portion of the total expenditure on a scheme. Thus benefits are net of operational and maintenance costs. If $C$ is the annual equivalent of the capital invested, $Y$ annual expenditure, and $X$ the annual equivalent of total benefits, then net benefits,

$$V = X - Y$$

and net present worth

$$NPW = V - C.$$ 

This terminology can next be used to show the fallacy of using the incorrect ratio of $V$ to $C$ to make project comparisons. It should be apparent without further discussion that,

$$\frac{X}{C + Y} \neq \frac{X - Y}{C} = \frac{V}{C},$$

or

$$\frac{\text{total benefits}}{\text{total costs}} \neq \frac{\text{net benefits}}{\text{capital costs}}.$$ 

The reason why this is important follows from questions of funding. The objective of a power authority is to make best use of its present investment funds, and it should not be concerned with future operating costs which will be covered by current revenue in the event. On the other hand, a solicitor or farm agency might be supplying all the funds for a considerable period of development; in this case it would not be necessary or possible to separate $C$ and $Y$. Forest development is another example where revenues come in very late, and the lending authority may want to know the best return on all funds supplied. This general problem does not occur if only acceptance/rejection criteria are required. Finally it should be noted that $V/C$ ratios calculated in different ways should never be used for bases of comparison.

I now turn to a discussion of development schemes which are to be funded from the public sector. The first step is to gather the necessary information from engineers, technical reports and other people affected, on prospective scheme costs and benefits. The resulting time streams of costs and benefits should be converted to present worth terms at a social rate of discount which reflects the community's willingness to forego present consumption for the future. There is likely to be a generally agreed on rate for this. If the net present worth is positive, the scheme is now eligible for more
detailed consideration. At this stage, the general conclusion must be that this kind of development appears to be a good thing. This might involve getting outside interests to investigate the scheme for private profitability or it might be a scheme where some or all of the benefits were recoverable from the beneficiaries.

The second step in the analysis is to investigate those financial and funding aspects of the scheme. This may involve assessing the private benefit of farmers, and getting capital or maintenance contributions; or assessing whether a suitable rate can be struck. The scheme may require a subsidy element to get it started and so on. On the other hand, future revenues may justify the scheme directly, and Government may simply provide the capital in anticipation of this.

The third step is to compare the scheme with other schemes under consideration. This comparison should include different scales of the same scheme if this is not already pre-determined by engineering considerations. As noted below, there is also an argument for considering whether to delay a scheme or not where the pattern of benefits would justify it. But the main reason for these comparisons is that all schemes with a positive net social present worth cannot usually be funded at once. Some person in central authority has to decide on the "best" investments. In economics, we would talk of ranking the projects in order of their worthwhileness.

For a given scheme, the worthwhileness or contribution to welfare is measured by the excess of benefits over costs, \( V - C \). But to put a set of schemes in their order or worthwhileness will obviously require more information than \( V - C \), as big schemes would always seem to generate the largest \( V - C \). In fact, the schemes have to be looked at in terms of the benefits created per $ of the capital finance, then \( V/C \) is quite appropriate. If some portion of the capital or other funds are contributed, then it should be clearly represented as \( V/C' \) and so on, where \( C' \) is the contributed portion.

I next mention the third criteria, the internal rate of return. If a project has a positive NPW at a conventional rate of discount, then there is some higher rate which would bring the NPW down to zero. This is the internal rate of return. This criteria has an intrinsic appeal probably because it is expressed as a percentage. But its use must not be confused with decisions involving time preference. It is time preference which reflects society's attitude to future income, and this must be the basis of selection. The IRR is best regarded as the limiting case; how high may this project's net benefits be discounted before the NPW is zero?
Secondly the IRR is not a consistent measure of project worth. I quote the following results from a forthcoming report of the Agricultural Economics Research Unit. Three development plans for a farm are considered for different rates of development. The figures are the net present worths at different rates of discount.

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>Fast $</th>
<th>Medium $</th>
<th>Slow $</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>+40605</td>
<td>+39938</td>
<td>+35609</td>
</tr>
<tr>
<td>10%</td>
<td>+10234</td>
<td>+10603</td>
<td>+8987</td>
</tr>
<tr>
<td>15%</td>
<td>+1744</td>
<td>+2782</td>
<td>+2560</td>
</tr>
<tr>
<td>20%</td>
<td>+1647</td>
<td>-180</td>
<td>+314</td>
</tr>
<tr>
<td>25%</td>
<td>-3191</td>
<td>-1456</td>
<td>-599</td>
</tr>
</tbody>
</table>

At five per cent (or at 6 per cent which was actually used), the NPW rule indicates that fast development brings the greatest net benefits. But as the discount rate increases, the pattern of the respective income flows is such that the relative positions of the speed of development programmes changes. If the IRR were used to rank schemes in this way it could give a different ordering from the NPW. This is incorrect.

The central authority may now be assumed to have this year's projects lined up for approval. Clearly the available funds are now allocated in order of worthwhileness. Complications may arise because of the differing size of projects. For example the best project, according to the formula, may use up to 90 per cent of the budget, requiring adoption of another project rather low down on the list to just use up the remaining 10 per cent available. It might then be possible that two projects intermediate on the list, each requiring 50 per cent of the available budget, might in combination be superior to the other pair. On the other hand, funds might be allocated on a slightly more flexible basis and these hard-and-fast decisions may not be necessary.

I would like to comment on the possible temptation to increase discount rates successively until only the number of projects which can be financed are left! It should be clear by now that this violates the time preference rule and could in fact lead to a different order from that rule.

There is another perfectly satisfactory method. This would be to weight the value of the $ used for a construction and capital works in the time periods concerned. This is sometimes called the "shadow price". Thus we make the capital cost more and more expensive until the required number of projects are eliminated. Again, decision making may be sufficiently flexible to avoid this kind of adjustment.
Finally in this discussion of public schemes I want to draw attention to the selection of the optimum combination of schemes. There are two points to be covered here. A given scheme may have several alternative construction plans, and may be amenable to unit type building where units of the scheme are added as required. Now there are mathematical procedures for working out the best way of implementing such a scheme. The agriculturists or engineers who design schemes may not hit on this optimum or best plan, but may be quite near it. Secondly, it should be clear that a group of schemes can in theory be analysed by the same principles. For example, the shadow prices mentioned above could be used to differentiate between different periods, and situations where delay is an essential component of net present worth would be automatically placed in their correct perspective. As I say, in theory we can set out the problem as I have very briefly indicated, but in practice these niceties are seldom necessary.

I turn now to net private present worth. I propose to discuss this in terms of the farm investment situation, but the principles are of course much more general than this. For a private firm, the question is what will be the gains from a given course of action? The problem is essentially one of isolating the (cash) effects of the course of action. We assume that the benefit of the investment are spread over a period of time and that some account of this must be taken. Thus the analysis must set out the time pattern of costs and returns, and the firm's opportunity-cost rate of discount applied to bring the streams to present worths. The opportunity cost of the firm's capital may not be known until some of the above calculations have been made, so it is likely that the analysis would start with the borrowing rate available to the firm. Corporate management would be likely to have pretty clear rules about these things; on New Zealand farms we have very little knowledge of the rates to apply.

Now for a given firm the comparison of alternatives can be simply done by use of the NPW rule. Funds are not strictly limited, and fairly small differences in the size of alternatives would not alter the ranking.

If funds are strictly limited there are two courses of action. The first is to estimate the returns on the same level of investment in each and choose that with the highest NPW. The second would be to plan the alternatives with the capital required to reach the (presumed) technical optimum, and to estimate a $V/C$ ratio to get the best return per $ of investment. From this point the ranking procedures previously discussed would apply.

In farm development, the stream of benefits can be identified by the additional revenues which come in after some well-defined base year. I will call this $V'$. The cost of the development plan is most easily identified by the value of additional inputs
required. Call this $C$. Then $V' - C'$ and $V'/C'$ can be identified accordingly, the ratio being interpreted as the extra revenue gained per $\$ \text{ of extra expenditure.}$

In some cases, these development plans are viewed from an incentive point of view. Assuming the extra expenditure involved is provided out of farm income and that net farm income is subject to income tax, then $V''$ might be additional personal income and $C''$ expenditure funded out of income (i.e., ploughed back profits). We can note that $V'' = V' - C'$ (personal income is extra revenue less extra costs including tax), and that $C'' = C - V$, and $C$ is greater than $V$.

At Lincoln we have used the internal rate of return to measure the extent of the incentive element in individual farm development programmes. The resulting percentage is easy to explain to an unsophisticated audience and is not being used for national policy recommendations. Even so, the IRR must be regarded as the limiting case in all circumstances and all investment decisions related to the time preference rules.

The analysis of individual firms or farms can take a different course. A representative sample of investment plans might be assembled to illustrate some national problem. One which we have been concerned with is the general profitability of hill country development in New Zealand. As far as each individual programme of development is concerned, its value to the country is measured as the net present worth of added income, i.e., $V'' + C''$. $V''$ might be thought of as additional exportable goods and $C''$ the additional resources drawn in to produce the goods. Now if it were desirable to place the components of the sample in order of their contribution to the national economy, then $V - C$ type of measures could be confusing. As suggested in my earlier paper a ratio type of measure is required,

$\frac{V''}{C''}$ or $\frac{V'' - C''}{C''}$ depending on what return we wish to maximise for a given amount of resources.

For this type of national viewpoint analysis we are at present exploring the question of aggregating the $V$’s and the $C$’s over a sample of development plans to arrive at a representative cost-benefit ratio. This work is proceeding.
Further Reading


2. R. J. Hammond, *Benefit Cost Analysis and Water Pollution Control*, Food Research Institute, Stanford 1959, Ch. II.


Mr Jensen, in his paper, has outlined the concepts we have used in the estimation of unit and project cash flows. He has pointed out that the faster the rate of execution of a project (other things being equal) the higher the present value of its cash flow, but the internal rate of return will be unaffected. The net discounted value/net discounted cost of the project cash flow is also affected by rate of project execution.

This leads to a problem situation in which the comparison of value between classes of development may be confounded by rate of development.

For instance suppose one wants to decide whether to use a block of land for either farming or forestry and present value is to be the deciding measure. For a convenient forty-year rotation one might slow up the forest development by planting one fortieth of the area each year. This project could have a lower present value than a farming project on the same block which was budgeted for rapid development. Yet it is possible that an acre of forest might have a higher present value than an acre of farm land development. In this case it would be wise to either compare the projects at the same rate/execution or use the present value of the unit cash flow to make the comparison.

As a second example, one may wish to know the priorities to give to three kinds of development. Historical data is available for the project cash flows of each kind of development but the three kinds of development proceeded at three different rates. Hence the value/net cost ratio, confounded by rate of development, may not give a measure of priority of the kinds of development.

In order to solve this problem, we have evolved methods of extracting unit cash flows from given data on project cash flows.

The Extraction of Unit Cash Flows:

The method uses multiple regression to determine values for the unit cash flow which, at the given rate of development, recreate (or estimate) the actual project cash flows, with the minimum error. The method will be explained with a worked example.

The hypothetical project cash flow shown in Table 1.

---

1 A measure used for giving projects a priority rating in a budget constrained situation.
Table 1.

Hypothetical Data on a Project Cash Flow

| Year | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cash Flow $S_j$</td>
<td>-400</td>
<td>-1400</td>
<td>-1300</td>
<td>-700</td>
<td>400</td>
<td>1100</td>
<td>1300</td>
<td>1350</td>
</tr>
<tr>
<td>Extra Units Commenced</td>
<td>100</td>
<td>200</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

We will make the assumption that the unit cash flow reaches stability in 6 years. In practice this assumption can be made on an "a priori" basis. We wish to determine values for a unit cash flow which we will term $b_1$, $b_2$, $b_3$, $b_4$, $b_5$ and $b_6$.

We will refer to the project cash flow, $-400 -1400 -1300 ...$ as $S_1$, $S_2$, $S_3$ ... etc and the recreated or estimated project cash flows as $\hat{S}_1$, $\hat{S}_2$, $\hat{S}_3$, ... etc. These will be different from the actual project cash flows, $S_1$, $S_2$, $S_3$ ... etc. The purpose of multiple regression is to find values for $b_1$, $b_2$, $b_3$, ... etc which minimise the sum of squares of difference between actual and estimated cash flows. The following equations show the relationship between unit cash flows and project cash flows for the data in Table 1.

\begin{align*}
\hat{S}_1 &= (b_1 x 100) \\
\hat{S}_2 &= (b_1 x 200) + (b_2 x 100) \\
\hat{S}_3 &= (b_1 x 50) + (b_2 x 200) + (b_3 x 100) \\
\hat{S}_4 &= (b_1 x 0) + (b_2 x 50) + (b_3 x 200) + (b_4 x 100) \\
\hat{S}_5 &= (b_1 x 0) + (b_2 x 0) + (b_3 x 50) + (b_4 x 200) + (b_5 x 100) \\
\hat{S}_6 &= (b_1 x 0) + (b_2 x 0) + (b_3 x 0) + (b_4 x 50) + (b_5 x 200) + (b_6 x 100) \\
\hat{S}_7 &= (b_1 x 0) + (b_2 x 0) + (b_3 x 0) + (b_4 x 0) + (b_5 x 50) + (b_6 x 300) \\
\hat{S}_8 &= (b_1 x 0) + (b_2 x 0) + (b_3 x 0) + (b_4 x 0) + (b_5 x 0) + (b_6 x 350)
\end{align*}

Some explanation may help. In equation (1), the project cash flow value for the first year is equal to the 100 units commenced (see Table 1) times the first unit cash flow value ($b_1$) and so on through to equation (7) and (8). The unit cash profile reaches stability at the sixth year, $b_6 = b_7 = b_8$ etc. Thus in equation (7) the last term is ($b_6 x 300$). This represents ($b_6 x 200$) + ($b_7 x 100$). Similarly the last term in equation (8) is ($b_6 x 350$). This is equal to ($b_6 x 50$) + ($b_7 x 200$) + ($b_8 x 100$) because $b_6 = b_7 = b_8$. 
Using Miss Matheson's multiple regression computer program we estimated the unit cash flows of

\[ b_1 = -4.79 \]
\[ b_2 = -3.96 \]
\[ b_3 = -2.94 \]
\[ b_4 = 1.03 \]
\[ b_5 = 3.33 \]
\[ b_6 = 3.82 \]

The next table shows the estimated and actual project cash flows.

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Project Cash Flows</td>
<td>-400</td>
<td>-1400</td>
<td>-1300</td>
<td>-700</td>
<td>400</td>
<td>1100</td>
<td>1300</td>
<td>1350</td>
</tr>
<tr>
<td>Estimated Project Cash Flows</td>
<td>-479</td>
<td>-1354</td>
<td>-1327</td>
<td>-685</td>
<td>392</td>
<td>1100</td>
<td>1314</td>
<td>1338</td>
</tr>
<tr>
<td>Difference</td>
<td>-79</td>
<td>46</td>
<td>-27</td>
<td>15</td>
<td>-8</td>
<td>0</td>
<td>14</td>
<td>-12</td>
</tr>
</tbody>
</table>

The sum of the squares of these differences in Table 2 are at a minimum - this being the criterion for the program to select these values for \( b_1, b_2, b_3 \ldots \) etc. Shown above.

The unit cash flow of

\[ -4.79, -3.96, -2.94, 1.03, 3.33, 3.82 \]

has almost the same internal rate of return as the project cash flow being 21.8% and 22.2% respectively. As Mr Jensen pointed out in his paper the unit cash flow and the project flow will have the same IRR in a theoretical context.

The application to Northland Data:

This method has been applied to the analysis of data from the "Northland Project" carried out by McArthur and Sanderson (1967). The data was from 32 dairy farmers who increased their stocking rate by 70% in an average of 6.1 years and 17 sheep farmers who made a 71% change in stocking rate in an average of 6.3 years. The change
in cash surplus compared with no development was calculated from the national point of view using constant prices over the period. The results from the sheep farms were aggregated as were the results from the dairy farms. These aggregate results are "project cash flows" and are shown in Table 3.

Table 3.
Project Cash Flow from Northland Data

<table>
<thead>
<tr>
<th>Year</th>
<th>SHEEP DEVELOPMENT</th>
<th>DAIRY DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extra Ewe Equivalents</td>
<td>Extra Cash Income $</td>
</tr>
<tr>
<td>1</td>
<td>3585</td>
<td>-183728</td>
</tr>
<tr>
<td>2</td>
<td>3897</td>
<td>-147404</td>
</tr>
<tr>
<td>3</td>
<td>6621</td>
<td>-109808</td>
</tr>
<tr>
<td>4</td>
<td>4519</td>
<td>-35716</td>
</tr>
<tr>
<td>5</td>
<td>2938</td>
<td>76804</td>
</tr>
<tr>
<td>6</td>
<td>2617</td>
<td>19696</td>
</tr>
<tr>
<td>7</td>
<td>2393</td>
<td>103404</td>
</tr>
<tr>
<td>8</td>
<td>1142</td>
<td>161648</td>
</tr>
<tr>
<td>9</td>
<td>252</td>
<td>179482</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>188960</td>
</tr>
</tbody>
</table>

Using the multiple regression procedure we extracted unit cash flows. We thought that four years was a likely time for the unit cash flows to reach stability but took also 3 years and 5 years as alternative assumptions.

The results are shown in Table 4.
Table 4.
Unit Cash Flows (Northland Data)

<table>
<thead>
<tr>
<th></th>
<th>SHEEP DEVELOPMENT</th>
<th>DAIRY DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t=3</td>
<td>t=4</td>
</tr>
<tr>
<td>Year 2</td>
<td>7.96</td>
<td>4.60</td>
</tr>
<tr>
<td>Year 3</td>
<td>3.32</td>
<td>7.34</td>
</tr>
<tr>
<td>Year 4</td>
<td>3.16</td>
<td>-5.18</td>
</tr>
<tr>
<td>Year 5</td>
<td></td>
<td>3.56</td>
</tr>
<tr>
<td>Present Value at 6%</td>
<td>37.90</td>
<td>36.22</td>
</tr>
<tr>
<td>IRR</td>
<td>21.04</td>
<td>20.61</td>
</tr>
</tbody>
</table>

The unit cash flows are in line with expectations. In both sheep and dairy development the initial cost is much the same and in close agreement with the estimate made by the Agricultural Development Council. These agreements are interesting but may be fortuitous.

The tendency for a declining of positive values in the unit cash flows after the initial cost probably reflects the behaviour of rapidly developing farmers who tend to keep running expenditure at the lowest levels during the period of most rapid expansion. Once initial development is over, running expenses tend to rise due to "convenience expenditure" to keep down taxation. However other explanations are possible.

The internal rates of return for all unit cash flows are close to the values for their respective project cash flows. The present value of the unit cash flows are very similar for alternative values of t.

The analysis provides:

(a) an unconfounded comparison between two classes of development, sheep and dairy development, from the present value of the unit cash flows which show dairy development to have a present value four times that of sheep,

(b) a unit cash flow for use in estimating the implications of farm development at different rates with the assumption that the unit cash flow profits would be unaltered at different rates.
REFERENCE

McArthur, A.T.G. and Sanderson, K.T. (Ag.Econ. No. 416)
PREPARATION OF ECONOMIC REPORTS FOR GOVERNMENT

- 'GRASS ROOTS' PROBLEMS

E.J. Stonyer
&
W.G. Donovan
Department of Agriculture

Despite the limitations and problems associated with cost/benefit analysis undertaken in this country, it can now be said that public agencies in New Zealand are attempting to justify the expenditure of at least some public money by the use of accepted economic criteria.

This paper briefly outlines the growing importance of economic reports in relation to schemes for rural development, and the problems which are becoming more acute as this work grows in quantity and complexity.

We all realise that in judging public investment proposals we cannot place sole reliance on economic reports to the preclusion of welfare and political considerations. However, in a country where development capital is becoming almost a luxury commodity, it is right that increasing weight should be given to quantitative economic analysis in assessing the soundness of investment decisions, even though the factual data available for preparing these analyses are sometimes limited.

The responsibility for making some sort of economic judgement regarding rural development projects involving public money in this country falls on the Department of Agriculture. It may be argued by some that this work should be performed outside Government agencies, but the fact that public funds are involved makes it unlikely that this will take place. One of the important functions of Government agencies is their provision of factual material upon which decisions can be made by elected decision-makers. These agencies are probably in the best position to draw material of a confidential nature from a wide variety of sources, and to present reports to decision makers which may be either favourable or unfavourable to certain sections of the community. Since these agencies are in no sense sponsored by partisan interests, there is freedom for reports to be as strongly for or against proposals as an objective analysis demands.

Early Development

Prior to 1959 no great stress was laid on economic reports, and little attempt was made to evaluate in economic terms any large scale rural development schemes in New Zealand. Until this time, reports indicated the probably physical effects of certain proposals, and
translated these into a course of action according to local social and political pressures. In 1959 we were faced with a large scale irrigation proposal in the final stages of fifty years of planning, a scheme where for the first time an attempt made to relate expected returns to costs influenced a Government decision in this field. On the evidence we had, this decision had to be a negative one, and a negative decision was made, in the face of intense local and provincial pressure. Although this particular issue is not yet entirely dead, the results of repeated investigations by independent committees and by the Treasury have pointed in the same direction, and it would now seem inevitable that the scheme as put forward will be 'put aside'.

Since this rather 'ham-fisted' attempt at quantitative economic measurement in 1959, the work has gained considerable strength. The use of discounting techniques in reports from 1964 onwards saw the introduction on a wider scale of some of the methods used for many years in the U.S.A., and the recognition of the usefulness of cost/benefit analysis in this field. From a certain amount of groping our way from one project to the next, there has emerged the possibility of an approach to larger scale, regional problems. Such a study has been recently completed for the Gisborne-East Cape area of the North Island. For the first time, over a large area, farming and forestry interests were studied in relation to problems of soil conservation, and an attempt made to choose or OOb' biutiou on a rational, economic basis. This is one logical development of the approach in New Zealand.

For our part the work load has increased substantially in the past five years. Other State departments, especially Works and Treasury, are routing scheme proposals to us for appraisal before they are sent forward to Government for consideration. It is very encouraging to see a fairly sudden acceptance of the necessity for analyses of a cost/benefit nature, and even an insistence that projects will not be considered without such preliminary appraisal. At the same time, it is a little frightening to see the enthusiasm with which some organisations are 'latching on' to methodology and approach, without considering very deeply the underlying physical facts. It can be dangerously misleading if rather flimsy physical data are masked by a sophisticated mathematical technique. Reports of this nature often assumed an air of authenticity which may have little foundation.

In spite of these misgivings, the important fact is that those making decisions in Government, and their advisers in this field, are today insisting on a detailed economic evaluation which conforms with recognised principles.

At this point in time we have over a dozen major schemes under consideration, ranging from Clinton in South Otago to the Hikurangi swamp in Northland. The capital outlay involved in these projects probably totals more than $25mn. These schemes include irrigation, land drainage and reclamation, flood and erosion protection, rural water supply, and other related fields of development, a far cry from the management reports prepared for livestock water and very sporadic irrigation proposals in the
Basic Problems

We will deal with the basic problems we face in carrying out this work for Government under the following headings:

(i) Staff training and retention,
(ii) National planning and priorities,
(iii) Physical data,
(iv) Political problems,
(v) The fifth problem area, that of basic methodology, I have taken to be the concern of many other contributors to this symposium. Therefore I have left the general field of discount rates, the criterion controversy, period of analysis, risk and uncertainty, premiums for overseas funds, etc., to be discussed elsewhere.

(i) Staff training and retention: At the present time we employ ten to a dozen University graduates. Four of these have completed, or are finishing studies at the Masterate level in Economics or Agricultural Economics. These people are part of the Farm Economics Section of the Department, and are not involved in advisory activities with individual farmers.

Economists who work in this sphere should have a broad training which permits them to communicate in technical terms with specialists in all the allied fields. It is most important that objective opinions and facts can be assembled and analysed from engineers, soil, plant and animal scientists, extension workers and farmers. This can only be achieved satisfactorily by economists who have two, or perhaps three strings to their bow. If economists don't have a sufficiently broad training to communicate with these other disciplines, many of their functions in project planning may be taken over by administrators, or people such as geographers who traditionally have a broad perspective. This would be unfortunate, as economics can be one of the best integrating disciplines, providing a basic framework for co-ordinating such diverse fields as engineering and agriculture. In a day of specialisation it may seem like heresy to advocate a broadly based training, but the fact remains that our problems are not completely answered by a group approach to evaluation of large scale projects. Perhaps the co-ordination needed here is like the co-ordinating function of management - rather an "unspreadable" commodity.

It would still be the case that a solid background in agriculture and agricultural economics is the most valuable training. Without sound agricultural knowledge the economist is not able to probe deeply enough on the benefits side of the evaluation, and it is here that most of our difficulties arise. At the same time it is possible for graduates in pure economics to pick up a considerable amount
of agricultural knowledge by doing such courses as the Diploma of Agricultural Science at Lincoln. With the increasing scale and complexity of many of our projects it is becoming clear that some training in mathematics and in computer techniques is necessary. Graduates in agricultural economics would find it valuable, though perhaps not essential, to have ventured a little more into the field of macroeconomics than has been the case in the past.

(ii) National planning and priorities: Apart from the implications here for the whole New Zealand economy, special mention should be made of the problems we face with regard to 'piece meal' rural development, and, on an even smaller scale, individual project development which takes little account of either alternative arrangements or implications for a larger region. It's true that a great deal of progress has been made in evaluating individual schemes, but there are still too many projects which reach the final planning stage before any attempt is made to consult with the economist about the factors which will make the project economically viable. Far too often the economist is presented with a scheme 'blue print' already discussed with the rural community, and faces the unenviable task of rejecting the scheme on economic grounds. There are several aspects to this problem, including 'getting ahead' of the politicians and others so that the economist can help with indicative planning, instead of wasting time analysing projects which have merely been set up in response to local pressure. Also involved are the concepts of optimum scale of projects and optimum sequences of projects.

In the irrigation field, for example, it should be possible to identify areas which are suitable, from the physical point of view, for development. An examination of soil and production data should indicate where the greatest physical responses can be achieved, and these should be related to all the available engineering alternatives. It is vital that economists should be part of the planning team right from the 'drawing board' stage. Technical efficiency is frequently not compatible with optimum economic efficiency. Only too often in New Zealand the scheme of maximum size receives the most attention, where economic analysis might have indicated that separable smaller schemes would have resulted in greater net benefit. The multiple-scheme concept is as yet relatively unknown in this country. A further danger is that this large single project may obscure side issues important for a whole region. A typical example of this was the proposal to irrigate the Maniatoto Basin in Central Otago. The development of this proposal not only necessitated the flooding of over 10,000 acres of farmland for storage purposes, but it virtually 'tied up' the water resources of the entire catchment. This meant that any possibilities for extensive irrigation lower in the catchment would be lost, together with any scope for industrial or other forms of development requiring large quantities of water. Fortunately this scheme in itself proved too costly, but had it been acceptable as a separate entity, and been implemented, future development of a wider area could have been seriously handicapped.
Of course, sometimes the opposite problem occurs - a series of small projects set up as local pressure groups' 'jump on the bandwagon', where one large scheme may have proved more beneficial. The South Island's East coast areas are becoming studded with individual rural stock water supply schemes which provide a basic ingredient for successful land improvement and livestock increase. Unfortunately they arise apparently at random, and the size of the scheme is related more to local support than to economic planning. It is often difficult to suggest workable alternatives which make optimum use of resources and also combine groups of farmers and a number of very independent local authorities.

In all these cases, Cost/Benefit analysis applied to separable marginal segments of a large scheme, or to separate schemes in a multiple project concept, can be of primary importance in working out problems of scale in relation to regional planning.

(iii) Physical data: This problem is perhaps the most 'grass roots' one of all, and an area where we experience the greatest difficulties. There is frequently a tremendous gap between the technique used to evaluate a proposal and the quality of the basic data we have to use. It does seem rather ironical at times to see rather imprecise, subjective values and estimates used in a precise, mathematical formulation. This does not mean that we should discard the technique until we have physical information to match. But it does mean that any one making decisions influenced by Cost/Benefit analysis should take very careful note of the assumptions which form the basis of the report, rather than merely having regard to some specific figure for 'present worth' or 'internal rate of return'.

The basic assumptions I am referring to here have to do with physical productivity, the pattern of agriculture, the achievement levels of farmers, and the setting of boundaries for project influence.

Firstly, there is physical productivity - yields of crops, and output of meat, wool and butterfat per animal, and per acre. We hope to demonstrate later with an example the kinds of effects changes in these factors can have on the result of a project evaluation.

Secondly, the pattern of agriculture - in some of the swamp development areas being studied in the North Island, there is the possibility that drained peat lands may not be used for sheep, beef cattle or dairying as are the farms currently surrounding the swamp. Instead there may be structural changes in the direction of market gardening, production of maize, or even rice in some areas. Not only do decisions have to be made about the pattern most likely to emerge, but details of the benefits associated with these alternatives may be difficult to procure, because of lack of farming experience with crops or lack of comparability with other areas. The problems of changes in agricultural patterns can also be considerable in evaluating irrigation schemes.
Thirdly, achievement levels of farmers. In some respects this can be the worst problem of all. We may be able to say with some precision what land is physically capable of producing with present technological know-how, but we know also that only a certain proportion of top farmers are likely to reach these levels. In being realistic about benefits arising from the development envisaged we must choose among feasible production levels which may cover a wide range, depending upon what assumptions are made about economic conditions, response of farmers to research results and extension efforts, and any non-economic motivating factors. Naturally such variations cause a great deal of uncertainty to surround any production levels chosen. Perhaps this is why this phase of the analysis has been the cause of the most argument and controversy in some economic reports.

Fourthly, a physical factor which has caused difficulty is concerned with setting boundaries for project influence, both spatially and temporarily. In reports on flood control or erosion-arresting projects, it has been traditional to speak of 'fringe' benefits which accrue to hill country run by farmers in conjunction with eroding areas. Sorting out the structural relationships between different parts of farming properties can be quite difficult, and may depend on factors which vary from farm to farm.

Associated with these problems are quite complex conceptual difficulties which are well illustrated by analysis of flood control proposals. In assessing flood damage to farmland we are concerned not only with the frequencies with which floods of various magnitudes occur, but with such factors as the period for which pasture is under water, and the time of the year at which the land is flooded. The critical length of inundation is different between Summer floods and Winter floods. Perhaps it is little wonder if an authority designing flood schemes is driven to despair by an agricultural economist who asks for a hundred years of flood records, covering frequency, depth and period of inundation for different areas, together with time of year and climatic conditions during the post-flood period!

In all of these problem areas we attempt to lay our hands on as much relevant research material as possible. But there often isn't much available; or what is available may be applicable only for some other area of New Zealand, or worse still, for some overseas country. The latter applied especially to important sociological research in the field of farmers' achievement levels. In the absence of research information it must be admitted that we are often forced to erect the whole evaluation on the foundation of subjective experience, as far as the physical benefits are concerned. The procedure is usually to make a close survey of the area being examined, and from this starting point draw upon the experience of extension workers in the district, while making assumptions about such things as level of achievement.
As the Government agency primarily concerned with agriculture in this country, much of the responsibility for this paucity of basic data must fall on our shoulders. For too long we have been a 'responding' organisation, moving from evaluation of one project to that of the next, with insufficient time to take stock and reflect upon likely future involvements. The time has come when we must attempt to anticipate development opportunities, and ensure that basic trial work is being performed which will allow accurate quantitative assessment of costs and benefits. We must also go back to projects already implemented to obtain more information about the pattern of development and the pressures which influenced the rate of improvement achieved. These efforts must be made if decision makers are to be confronted with something more than subjective assessments (or worse, unsubstantiated 'guessestimates'), which in the long run will scarcely enhance the reputation of cost/benefit analysis.

(iv) **Political problems:** For the economist working in the field of preparing reports with which he hopes to influence Government decision makers, it is only a very short time before he is aware of the range of political intrigues which can surround a development scheme of any magnitude. These become particularly obvious when he presents a report adverse to the proposal being considered. It might be expected that a favourable report, recommending the expenditure of large quantities of capital, would be the one subjected to closest scrutiny, but unfortunately this is not so. Local opinion is most often inclined towards development projects, because the subsidised capital investment is considered to confer benefits on the region. An economist presenting a report conflicting with local opinion risks being labelled a 'public-enemy' by both agricultural interests and urban progress associations. Apart from these unpleasant side issues it is often necessary to go to extreme lengths to ensure that potentials favouring the scheme are not understated and costs are kept to a minimum. These situations can be avoided to some extent if those responsible for planning projects have discussions at an early stage, and avoid making proposals public before their economic feasibility has been examined.

Another point regarding 'unfavourable' reports is that there is always strong pressure for their being published. There can be no doubt that from most points of view this is a desirable course of action, which should be encouraged. Where this has been done, however, the result is frequently a series of recriminations, new committees to make re-examinations, and a general waste of skilled manpower. There are plenty of 'likely' schemes requiring attention, without economists wasting their time in travelling over the same ground three and four times, with ever increasing sophistication of technique, and minor alterations in parameters, to give substantially the same verdict as before.
The presentation of the reports themselves is a matter of the utmost importance. Great care must be taken to fairly summarise the results in the most objective fashion, so that the reader is quite sure in his own mind regarding both the procedure which has been followed, and the outcome of the investigation. It should be also quite clear at what point variations in the assumptions used affect the final result. This point is traditionally covered by some sort of 'sensitivity analysis', which sets out, beside the outcomes considered most likely, the implications of changes in prices and costs, discount rates, and temporal sequences in development programmes. Sensitivity to changes in physical parameters has not been very widely incorporated to date, but it is an area which must be included increasingly in the sensitivity analysis.

The main difficulty here is one of clarity. The economist is only too well aware of the pros and cons which surround some of his basic assumptions. He is tempted therefore to draw up a very thorough set of alternative solutions, showing a fairly wide range of variation in the parameters. But a balance has to be struck between satisfying the demands of 'objective honesty' and serving the needs of the decision maker. If the conclusions are not set out clearly, or if the sensitivity analysis is cluttered with alternatives, the decision maker may be more bewildered after reading the report than he was before reading it.

We are under no illusion that the economic report is anything more than one factor in the decision process. But nor do we wish to reduce the impact of an economic analysis by clouding it about with too many 'ifs' and 'buts'.

In the above remarks we have made no attempt to discuss problems relating to other features of investment analysis - discount rates, technical methods for assessing any premium for overseas funds, the criterion controversy, period of analysis, etc. These are also our problems, but they have been discussed elsewhere.

By emphasising the difficulties relating to collection of physical data, handling the impact of political factors, and moving from the 'responding' stage to the 'initiating' stage in our investigations; by speaking about our staff needs and the conceptual problems involved in projects with different ends; we have tried to give you a picture of our activities in the preparation of economic reports, and the main problem areas as they appear to us.
COMPUTER PROGRAMS FOR PROJECT EVALUATION

A.T.G. McArthur
Senior Lecturer in Rural Education
Lincoln College

INTRODUCTION

Project evaluation demands a great deal of calculation some of which can now be done with a computer. If the analyst has access to a computer, he has four options open to him when faced with laborious calculations.

1. **Do it by hand.** This can often be the best option if each calculation is different or the job is so small that the overhead cost in time of writing a program is likely to take as long as doing it by hand.

2. **Write a program for the job.** This option can save a great deal of time if the analyst can write a program himself or if he has a tame programmer who will write programs for him. In either case it is advisable for the analyst to have a clear idea of the sequence of calculation he wants carried out and consequently it is advisable to do a simple example of the calculation by hand first so that he can easily visualise each step in the calculation.

   It is also advisable for non-programmers to have some understanding of computers and programming by attending an introductory course on the subject.

3. **Modify an existing program.** Often a program has already been written for a similar job and with slight modification it can be used for a specific calculation. Usually it is not easy to modify a program which has been written by another programmer. Programmers have an inner knowledge of their own programs which is not easily communicatable.

4. **Use an existing program.** This is the easiest alternative. The analyst must know what programs are available and he or his programmer must know how to use them. It is the purpose of this paper to describe the programs the author has written for his work which are available to others.

PROGRAMS AVAILABLE

1. **Summary PVIR**

   This program calculates the present value at a specified
rate of interest of stream of income whose last value is capitalised. Then it calculates the present value/present value of net costs ratio at the specified interest rate. It calculates the internal rate of return using the Newton-Raphson method. The method is called Summary PVIR because it will aggregate a number of cash flows of equal length.

Example Input
First Card: //b 1 XEQ bCBIRS
Second Card: 0402bb.060
The 04 is the number of years in the cost benefit streams and 02 is the number of cost benefit streams to be aggregated, 2 in this case. Usually there is a 1 in this fourth column of the second card because usually only one stream is being discounted.
Third Card (gives first stream):
   bbbbb-200.  bbbbb-200.  bbbbb-400.  bbbbb100.
Fourth Card (gives second stream):
   bbbbb-100.  bbbbb-100.  bbbbb-200.  bbbbbbb50.
From the third card onwards ten columns are used for each time period. The decimal point can be put anywhere in the ten columns. If more than 8 periods are involved carry on to succeeding cards. However begin each new stream on a new card.

Example Output
Cost Benefit Stream
   -300.00  -300.00  -600.00  150.00
Present Value at 6.0 per cent 0.10452587E 04
Present Value/Net Discounted Cost 0.9919
IRR 0.11474  Present Value at IRR 0.83281

The 0.10452587E 04 means 0.10452587 x 10^4 = 1045.2587.
This kind of output makes the program very flexible.

The IRR is expressed as a proportion. 0.11474 is about 11.5% interest. The Present Value at the IRR shows how close to zero the present value is at this rate of interest.

2. Case History Analysis

The program was designed to carry out project evaluation studies by the methods reported in A.E.R.U. Publication No.10 1965 in which I reported on the value of two farm case history studies on Banks Peninsula.

The method adopted was to extract technical information on

1 b stands for a blank. The first symbol goes in the first column. In this case / is the first symbol.
the inputs and outputs on the farm and multiply these by expected prices for the future. Not all the costs can be extracted in technical terms. There remains a lump termed "farm expenses" in dollars from which it is impossible to dissect the technical information. These expenses are inflated to present day levels by a price index.

The program calculates the three cash flows, one from the national point of view, one from the Inland Revenue's point of view, and one from the Individual's point of view. Inland Revenue's point of view is the accounting profit which is used to calculate tax. This must be subtracted in the case of development from the individual's point of view.

The program then uses a subroutine to calculate present value, present value/present value of the net cost, and the IRR. This is calculated for the change in cash flow resulting from development.

The following is a "print out" from the computer of a case history of dairy farm development in Northland. The farm belongs to Mr C.E. Booth of Titoki.

I have added additional labels and information. The print out does not include

(a) the labels for the items, Butterfat etc.
(b) The explanation of the composition of the cash flows and accounting profit.
## CASE HISTORY ANALYSIS OF FARM NUMBER 6

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<th>ITEM</th>
<th>16000.00</th>
<th>20735.00</th>
<th>21887.00</th>
<th>22632.00</th>
<th>24534.00</th>
<th>32509.00</th>
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<td>-70.00</td>
<td>0.85</td>
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### RESULTS

#### NATIONAL POINT OF VIEW

- **CASH FLOW**: $\sum \frac{P_i}{I_{ij}} - \text{CAP}_j$
- **PRESENT VALUE AT 5 PER CENT 11264.**
- **VALUE/COST RATIO 2.428**
- **INTERNAL RATE OF RETURN 18.2 PERCENT**

#### INLAND REVENUES POINT OF VIEW

- **ACCOUNTING PROFIT**: $\sum \frac{P_i}{I_{ij}} + \text{STK}_j - \text{DEP}_j - \text{INT}_j$
- **TAX**: $f(\text{PROF}_j)$
- **EXEMPTIONS**

<table>
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<th>1884.</th>
<th>2442.</th>
<th>2470.</th>
<th>2553.</th>
<th>2615.</th>
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<th>2963.</th>
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<td>307.</td>
<td>492.</td>
<td>514.</td>
<td>546.</td>
<td>571.</td>
<td>897.</td>
<td>718.</td>
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</tbody>
</table>
FARMERS POINT OF VIEW

CASH FLOW \( CASH_j = \sum_i P_i i_{ij} - INT_j - TAX_j - CAP_j \)

1576.  -3524.  1796.  1558.  2342.  2443.  2245.


PRESENT VALUE AT 5 PERCENT 4944. VALUE/COST RATIO 1.024 INTERNAL RATE OF RETURN 11.4 PERCENT

HOLD BEFORE DEVELOPMENT CASH INCOME AND ACCUMULATE AN OVERDRAFT AND THEN REPAY IT

YEAR  PROFIT  TAX  CASH  OD
1  2412.  492.  1576.  5101.
2  2088.  375.  1576.  5125.
3  2169.  403.  1576.  5384.
4  2211.  418.  1576.  4869.
5  2984.  727.  1576.  4198.
6  2648.  584.  1576.  3711.
7  2685.  599.  1576.  3203.
8  2723.  615.  1576.  2672.
9  2763.  632.  1576.  2118.
10  2804.  649.  1576.  1940.
11  2847.  668.  1576.  937.
12  2893.  687.  1576.  309.
13  2940.  708.  1923.  0.
14  2963.  718.  2245.  0.
15  2963.  718.  2245.  0.

PV OF BENEFIT  5384.
3. COPE System

Mr Sanderson and I have developed two programs for development budgeting. These programs and the versions of them which will be developed as time goes on have been given the acronym COPE standing for Computer Overdraft Prediction and Evaluation.

While these programs have been developed for the individual farmer they can be used in project evaluation. For instance the COPE program for sheep farm development has a very comprehensive stock reconciliation in it. Students have used this program for a cost benefit study of farm development on the West Coast. The output of the COPE program was fed into the Case History Analysis program to give the results they required.

Mr Cleland has suggested that in Drainage and Irrigation studies it would be feasible to calculate a development budget for each farm in the district, with and without the scheme. Normally the clerical effort would be beyond the value of the information, but with computer services available such a proposal may be a useful tool in project evaluation.

SUMMARY

I believe that many of us are deterred from project evaluation studies because of the burden of clerical operations with computer services now available this deterrent is now removed. However we must remember the words of Lady Lovelace, the first computer programmer. She was an enthusiastic supporter of Charles Babbage and his pre-set mechanical calculator. She wrote, "the analytical engine has no pretensions whatever to originate anything. It can only do whatever we know how to order it to perform."
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A CASE STUDY OF FARM DEVELOPMENT

(Ex Auto)

N.W. Taylor

Lincoln College

The classical problem which the developing farmer is confronted with at the initiation of a development programme is in deciding on the rate at which development should proceed. Given technology, costs and prices, and the farmer's objectives, should the farmer develop slowly, out of internally generated income, or more rapidly through the injection of external capital (e.g. Development Loan)? The objective of this study (of a 900 acre light plainsland farm) was to analyse the effect of rate of development on profitability. In particular the change in farmer's income following development, and the appreciation on his net worth position as a result of development was investigated. This study involved firstly the establishment of a pre-development budget. From this point two development programmes were projected forward, budgeting out each year, and developing the farm from 1.5 s.u. acre to 3 s.u. acre at two rates, i.e. over 10 years and 6 years.

In the first case it was assumed that the development was from farm income and within the $10,000 overdraft limit imposed by the stock firm. In the second case the injection of additional external finance enabled the rate of development to be increased. From the budgets the change in income over base year was calculated for each year of the development, and the stable post development situation. Based on these figures the relative profitability of the alternatives was compared.

Since the physical level of development achieved was similar in both programmes, the post development surplus was also similar, although the time which lapsed before this was made available differed. In assessing the profitability of the two development programmes from the individual farmer's point of view, present worth, annual annuity and internal rate of return were calculated. It was found that the present worth of slow development was greater than that of the more rapid development programme. Dissecting the total present worth into its two distinct fractions it was shown that when comparable post development surpluses were capitalised into perpetuity and then discounted over the development period that the more rapid development gave the higher net worth. However the cost involved in obtaining the higher income earlier, more than compensated for the advantage gained in terms of time.
This then accounted for the overall or total present worth being highest for the slower development programme. (This highlights the sensitivity of the technique to the nature of the development streams). Internal rates of return of 24.6% and 15% were calculated for the slow and rapid development programmes respectively.

When looked at in terms of extra income and net worth the farmer achieves through development, it was demonstrated that although increased income is obtained sooner by rapid development the farmer's net worth is lower at the end of the development phase. However if the extra income earned over the subsequent 4 years is saved, then the farmer's net worth at the end of 10 years is comparable for both programmes.

A NOTE ON THE WORLD BANK'S ESTIMATION OF SECONDARY BENEFITS IN TANZANIA

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Apart from assessing the loss of former output involved in the movement of settlers to a new scheme, the World Bank estimates secondary benefits to a scheme through a tax formula. With regard to Tanganyika (as it then was) they estimated that all goods purchased with income from the settlement scheme would increase Government revenue through indirect taxes. Careful assessment of the incidence of tax is required, but the Bank found that import duties and excise duties from agricultural incomes averaged 12 per cent, those in processing and transport averaged 20 per cent, and those in personal consumption 17 per cent. The latter is the mean incidence of indirect tax in Tanganyika.

The assessment of a scheme might work as follows: If $100 is the net income of scheme farmers in a period, then $12 is collected by the Treasury from the goods bought. If one fifth is assumed to be processor's income (or some independent estimate of such), then this is taxed at 20 per cent to yield a tax return of $4. Now $120 of secondary purchasing power is created, of which 20 per cent is net income; this is
taxed at 17 per cent, giving a further yield of

\[ \frac{20}{100} \times \frac{17}{100} \times 120 \times \frac{20}{100} \times 17 \]

and so on.

The Bank thus assumes that central Government is sponsoring
the project, that the increase in Government revenue obtained by
taxation from the incomes generated by the scheme can be alloca­
ted to the interest on overseas or other loans, and that a
benefit-cost ratio on direct returns less than unity could be
tolerated in some circumstances. The method has the dis­
advantage that it assumes an average year of operation and does
not directly discount a stream of revenues or benefits.

Reference "The Economic Development of Tanganyika",
International Bank for Reconstruction and Development,
November 1960, Government Printer, Dar Es Salaam.

A NOTE ON SECONDARY BENEFITS IN
A LAND SETTLEMENT SCHEME
IN ZAMBIA

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This particular scheme was financed by a grant from a mining
company and had as one of its objectives, the stimulation of the
local economy. A 1000 acres forest was felled and divided up
into 30 acre farms. The area was 400 miles from the government
capital. Secondary benefits were therefore defined by the
objectives of the original grant - that the local people should
be better off. The analysis must therefore concentrate on
local benefits of the scheme in all its aspects.

Project costs of the scheme were the expenditure by the
regional government on establishing the project, and the con­
tinuing expenditures of the settlers on farm inputs. Capital
and recurrent expenses were lumped together.

Primary benefits of the scheme were measured as crop output
at farm gate prices.
Capitalisation of future returns were based on the depreciated value of the capital assets created. This corresponds to salvage values in engineering economics.

What were the regional benefits of the scheme? We identified two kinds of secondary benefit. That associated with new industries created by the scheme, and the increase in regional income which resulted from its presence - i.e. the multiplier effect. The only industry stimulated by the scheme was maize processing roller meal. The added net income of the firm concerned was counted as the benefit.

It was assumed that there was no transport benefit in the region because transport was controlled by a national organisation. The remaining crops of groundnuts, millet and tobacco were not further processed within the region. Fuel and supplies were bought through central government stores so no local trader benefited.

Local spending generated by the scheme was thus construction wages and rations, net crop income to the project agency or settlers, plus the above processing income for maize. The benefit of the local spending was assumed to be 20 per cent of increased turnover, i.e. traders and processors got increased net income of 20 per cent of turnover. A further 20 per cent of this 20 per cent could be calculated for the second round of multiplier effects and so on.

The total benefit-cost ratio was 0.64 with secondary benefits and 0.55 without. Various important policy issues with regard to regional benefits can thus be high-lighted by an analysis of this sort.

Summary

Soil conservation subsidies are granted on a cost sharing basis by Government and local body agencies for management practices and capital expenditure reducing actual or potential erosion. The study is investigating the outcome of a run plan initiated in 1966 from a national and individual view point.

Subsidies have been granted for the retirement of Class VII and VIII land (off-site subsidies for the development of areas of equivalent grazing) and for soil protection work (on-site subsidies).

Budgets have been prepared for high, low and average price situations. These compare the effects of on-site, off-site and full subsidies (on plus off-site) with development in the absence of subsidies. Constant levels of production have been adopted but the effect of the high degree of climatic uncertainty will be taken into account in the evaluation.

Preliminary results indicate:

1. Most methods used at present by the agencies providing subsidies tend to overestimate the amount of equivalent grazing required to replace the Class VII and VIII land retired.

2. The rate at which land is retired from grazing, or on-site protection is implemented is dependent on the rate of farm development. This is a result of implementing the subsidies on a cost sharing basis. The soil conservation programme thus becomes dependent on the level of annual cash surplus available for development and a function of the level of prices and climatic variability.

It appears that some programmes which could be completed in three years in a high price regime cannot be implemented at all in a period of low prices or years of poor stock performance.
Alternative methods of off-setting the cost of the soil conservation programme to the individual but which would still enable the programme to be implemented in a period of low net profits include:

a) a lump sum payment as compensation to the individual for the loss of grazing of the Class VII and VIII land.

b) payment of the on-site subsidies assessed in the Run Plan as a lump sum at the commencement of the programme. The conservation work undertaken in the early years of a programme would thus be paid for entirely from subsidies but in the latter years by the individual.

Other methods will also be assessed.

3. The amount of compensation offered will be excessive if the loss of grazing from land retirement is overestimated. Alternative methods of assessing the amount of compensation will be considered including the productive valuation of the land being retired.

4. Some methods of evaluating the outcome of the programmes may lead to conflicting or obscure results. An attempt will be made to assess the suitability of the alternative evaluation techniques where the degree of uncertainty is very high as in this environment.

A STUDY OF THE RATE OF INVESTMENT FOR A REPRESENTATIVE FARM (FARM DEVELOPMENT IN SOUTHLAND)

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In this study we have considered the problem faced by the representative Southland intensive sheep farmer who has been developing steadily, who has now reached a comparatively high level of development and who wants to know if further development is a paying proposition.
Budgets of costs and benefits likely to be associated with different rates of development on a 240 acre farm (the modal size) were prepared. Each development plan allowed for an increase in stock rate from 5.5 ewe equivalents per acre (the modal stocking rate) to 8.0 ewe equivalents per acre (the highest level deemed practicable with the present state of knowledge). Project evaluation criteria were then applied to the resulting income streams.

Three programmes were budgeted so that the desired objective at 8.0 ewe equivalents per acre was reached after 4, (rapid), 8 (medium) and 16 (slow) years. An allowance for declining stock performance at the faster rates of development was incorporated in the budgets.

As a further attempt to approach the real problem faced by farmers confronted with uncertain future prices the analysis was carried out under three different price assumptions.

1. Pessimistic prices

Inputs and products were valued at current (1967) prices.

2. Price squeeze

It was assumed that input prices will move upwards and product prices will fluctuate in the next 16 years as they have over the last 16 years.

3. Average prices

Inputs were valued at current prices and products were valued at the average prices of the last 11 years.

The Results

All development plans are profitable even under pessimistic and price squeeze conditions.

There is not much to choose between the fast and medium rates of development at a 6.3% discount rate but both are more profitable than the slow rate.

At higher discount rates, e.g., 10% and 15% the medium rate shows up favourably compared to the other two. At discount rates higher than the internal rate of return the faster programmes have higher negative net present worths. The programme chosen will thus be the one that is most profitable when the income stream is discounted at the individual rate of time preference.
EVALUATION OF THE POTENTIAL OF A NEW TECHNOLOGY

(PAKIHI)

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One of the problems of agricultural Investment Evaluation is technological uncertainty. This is well illustrated in a study at present being carried out on the economics of Pakihi development.

The Pakihi soils of Westland cover approximately ½ million acres, and until recently attempts to develop these problem soils have been unsuccessful. However, the Department of Agriculture have now taken over a block of 400 acres of raw Pakihi at Bald Hill, hear Westport, and they are showing on this demonstration farm that development of Pakihi is physically possible. We, for our part, are investigating the economics of this development. Our study is therefore based on the Pakihi land surrounding Westport where there are 40,000 acres of easy to flat unfarmed Pakihi. The present cover of this country is rush, umbrella fern, sedges and mosses. The peat soil is extremely wet due to the high rainfall, flat terrain and cemented gravel pan lying just below the surface. On first sight the Pakihi appears a most unattractive proposition.

However the development technique being used by the Department of Agriculture is surprisingly uncomplicated and straightforward. The major steps include:

1. Sub division
2. Aerial oversowing and topdressing in spring either direct into the native cover or after burning.
3. Formation of shallow surface drains by blasting and tractor mounted "spinner".
4. Water supply.
5. Stocking. It appears from results so far that 4 ewes per acre can be carried within 6 months of the initial topdressing, increasing to at least 5 ewes within 18 months of this initial treatment.
In this study we plan to investigate three aspects of Pakihi development:

1. The economics of development from the traditional family farm point of view, the effect of farm size on profitability, and the minimum acreage necessary for economic development.

2. The economics of development, assuming that Pakihi blocks are attached to already established farms. Development of the Pakihi blocks in this case could then be carried out, without significant increases in buildings, plant and labour.

3. Finally, to investigate the possible role of Government subsidies in the development of West Coast Pakihi.

The flows of revenue and variable costs in the base development programme will be calculated on a per acre basis. Assuming a certain rate of development, the cash flows for any farm size can then be calculated. Fixed costs of buildings, plant and labour obviously cannot be handled on a per acre basis, as they are 'lumpy' inputs. These fixed costs will therefore be determined separately for each farm size.

If our calculations show Pakihi development on a per unit farm basis to be uneconomic we feel sure that this will not be due to the special nature of the Pakihi country, but rather to the fact that Pakihi is completely virgin. Development of this country requires starting completely from 'scratch', and the necessary high initial outlay for buildings and plant will obviously be critical to overall profitability. This can obviously be paralleled to all development out of virgin land in New Zealand.

I would emphasise the importance of technological uncertainty in this study. We are, in effect basing our technical assumptions on the initial work at the Westport demonstration farms. Nevertheless we feel that the results obtained so far on this farm are sufficiently encouraging to warrant a study of this kind.
EVALUATION OF RESEARCH PROJECTS

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The present value estimates of research projects should include, (1) the value when the results are applied (2) the rate of adoption (3) the probability of success (4) the cost of research.

The following model determines the value of a machine which could be evolved by research.

(a) The value of the machine if successfully developed is

\[ V = \sum_{t=1}^{\infty} \left[ \frac{S \cdot A \cdot (1+i)^{-t}}{(P_0 - 1)^{t-1}} \right] \]

where
- \( V \) is the present value of the project if successful
- \( t \) is the number of years after the project is launched
- \( S \) is the cost saving per acre
- \( A \) is the number of acres
- \( i \) is the interest rate
- \( P_0 \) is the proportion of total acres using the new machine when the machine is launched
- \( e \) is the exponential constant
- \( r \) is the rate of growth of adopted acres per year.

Verbally, this value is the discounted saving per acre times the number of acres which have adopted the new machine.

(b) The expected value of the project is

\[ E(V) = \sum_{j=1}^{n} (P_j \cdot V \cdot (1+i)^{-j-C \cdot j}) - P \cdot C \cdot n \]

where
- \( E(V) \) is expected present value of the research project
- \( j \) is the year during the research phase of the machine development
- \( n \) is the year after which no more efforts are made to develop the machine
- \( C \) is the annual cost of research
- \( P_j \) is the probability of successful development in the \( j \)th year
- \( P \) is the probability of failure after \( n \) years
  \( (P_1 + P_2 + P_3 + \ldots + P_j + P_n + P = 1) \)
Saltwater Creek drains the watershed between the Kowhai and Ashley Rivers. The Ashley-Sefton drainage scheme covers an area of relatively flat low lying land between the coast and clay downs. By 1946 the growth of willows in Saltwater Creek and its tributaries had seriously obstructed natural water flow and after periods of heavy rain the adjoining land would flood. In 1947 Mr A.H. Flay of Lincoln College reported that it was a region of good soil capable of much increased production in which drainage should not only prevent deterioration but assist to increase production. In light of the production possibilities foreseen and the estimation that $6/acre of capital works would result in $1 p.a. of extra net farm profit, Flay concluded that the scheme would be economically justified. In 1949-50 the North Canterbury Catchment Board cleared the existing waterways. The willows were removed and the existing water courses deepened and in places straightened. Before the scheme was installed part of the area had been resettled with ex-servicemen, and the Forest Service had planted the severely eroding catchments of Fox's and Stony Creeks. These creeks are the main tributaries of Saltwater Creek and flow from the downlands into the scheme area. The planting and resettlement had by 1950 already altered the pattern of flood drainage and production.

To measure the direct effects of the drainage scheme it was found useful to apply the concept of "with and without". The direct effects of drainage being analysed as the difference between what the area is like today in comparison with what it would have been like if the scheme had not been installed. The area for finding the direct effect of the scheme is not confined to the scheme area specified on an engineering plan, but is the total area of all landholders affected. For example, a farm which has part affected by the scheme. It is conceptually correct and clearer to consider the additional effect on the whole farm than it is to try and measure the effect on the drained area. The type and level of production as recorded in 1947 would not represent what the area would be like without the scheme now, as in the last 20 years there have been increases in farm technology and relative price changes for the various farm inputs and outputs.
Graphically the situation may be presented as follows:

**The Effect of drainage upon Production**

![Graph](attachment:image.png)

*Area:* $E, B, C, =$ direct effect of drainage  
$A =$ level of production 1946-47 - measured in pre-investment survey  
$E =$ Level of production 1949-50 - installation of scheme  
$C = " " = 1966-67 - without scheme  
$B = " " = 1966-67 - with scheme, as measured in post-investment survey.

The production existing under relative prices and technology in 1946/47 would no longer be considered rational under 1966/67 conditions. The slope of $A, E, C,$ would not only be due to increases in technology and prices of a given form of production (e.g. dairy 212 lb. B.F./cow to 315 lb. B.F./cow) but also in a change in the form of production (e.g. dairy to sheep, oats to wheat).

For comparison of pre- and post-investment analysis it is necessary that benefits and costs are discounted to the same date. The start of capital works was considered the most appropriate date. As the purchasing power of the dollar is also continually changing, it was necessary to first adjust the benefits and costs by applying an appropriate price index.

Post-investment analysis can be considered as exploring the following questions.
Were the original predictions correct?

(ii) Has what happened been profitable?

(iii) Would what has happened been profitable given present day prices?

(ii) is the analysis of the real situation. In all circumstances it may not be regarded as the complete answer, as past unexpected, non-recurring gains or losses (e.g., 1952 wool boom) could mask underlying events. The imposing of past and present prices to the actual physical events that have taken place will not give satisfactory answers to (i) and (iii), because volume and type of production are dependant upon absolute and relative prices. If past and present prices are applied to historical events they will understate profitability if income prices have risen and overstate profitability if income prices have fallen. Post-investment evaluation although difficult and imprecise, highlights the pre-investment assumptions and problems.

A RETROSPECTIVE EVALUATION OF PUBLIC INVESTMENT
(Drainage)

A. C. Norton
North Canterbury Catchment Board

Catchment Boards invest a considerable amount of money (ratepayer and Government) in public works. Very little is known of the actual returns from these investments from the national point of view.

The North Canterbury Catchment Board has already carried out the retrospective evaluation of the L II drainage scheme, 1946/47, eighteen years after the scheme was established. At the present time a similar evaluation is being carried out on the Sefton-Ashley Drainage Scheme of 1949.

The retrospective evaluation is concerned with:-

(a) The physical increase in production and the time rate of increase that has occurred as a result of the scheme, e.g., increased acreages of crops, increased stock carrying capacities, increased yields per acre or per head.

(b) The conversion of the physical increases into net annual incomes - i.e., gross income less the additional running costs incurred.

(c) The capital cost of the scheme and of its subsequent annual maintenance.
(d) The cost and timing of any necessary capital land development.

(e) The conversion to constant prices of incomes and costs over a period of years using an appropriate price index.

(f) The presentation of the adjusted figures as income and cost streams.

(g) Calculating the discount rate at which the present worth of the income stream equals the present worth of the cost stream, that is the internal rate of return.

For the L II Drainage Scheme, 1946-47, the internal rate of return for the eighteen year period was 12 per cent.

THE USE OF EVALUATION METHODS IN CALCULATING THE MAXIMUM FEASIBLE INVESTMENT IN A GIVEN PROJECT (Drainage)

A.C. Norton
North Canterbury Catchment Board

Catchment Boards as part of their statutory requirements are concerned with protecting land from floods and improving land drainage. Both types of work can involve major expenditure of money.

As part of the planning procedure for new schemes, the North Canterbury Catchment Board generally does the following:

1. A preliminary appraisal is made by staff to determine firstly if the problem can be technically remedied and secondly if benefit will result from the scheme.

2. If the preliminary appraisal indicates that the scheme warrants full investigation, a detailed report is then prepared along the following lines:
(a) The problem is defined - as to its nature, extent and detrimental affect on land and improvements.

(b) An assumption is made as to the standard of the possible engineering works - e.g. protection to the 50 year flood frequency; a drainage outfall for all into properties into a public drain with a 95-100 per cent efficiency.

(c) Estimation of the physical increase in production and the time lag that is likely to occur as a result of the assumed scheme being established, e.g. increased acreages of crops, increased stock carrying capacities, increased yields per acre or per head.

(d) Estimation of the physical losses that will not occur because of the assumed scheme.

(e) Conversion of the physical increases and or physical losses not suffered, into net annual incomes - i.e. gross income less the additional running costs incurred.

(f) Estimation of the cost of any capital land development work and when this is likely to occur.

(g) Show (e) and (f) above as income and cost streams in constant terms?

(h) Take a given interest rate - say 6% - and find the present worth of the income stream and of the cost stream. As the cost stream represents only that of the land development and does not include the capital cost nor maintenance of the proposed scheme works, its present worth will probably be less than the present worth of the income stream. This difference in present worths represents at the 6 per cent rate of return, the upper limit which can be justified for the initial cost and subsequent maintenance of the proposed scheme, to the assumed standards.

The questions then to be resolved are - firstly - can a scheme giving the assumed benefits, be constructed and maintained for not greater than that price?

and secondly - can the ratepayers at that price finance the scheme?

(i) At this stage in the investigations, the problem, the expected returns and the expected costs are all defined. This gives a sound base for the interested parties to discuss, to negotiate and or to explore alternatives.
This project was an investigation of the applicability of the
internal rate of return formulation in evaluating ex post hill country
development. The data used was derived from the results of two case
study farms over a thirteen year period. (1948-1961.) Apart from the
results which were interesting in themselves this project highlighted
some of the basic problems likely to be encountered in economic evaluation
projects of this type.

Reinvestment versus Borrowing: in both cases all development was
financed out of income so that the problem of marginal borrowing and
lending rates of interest was not vital to the analysis.

Status Quo Situation: in both cases development was triggered off by
the 1950-51 wool boom which coincided with the advent of aerial topdressing
as a commercial proposition. In the three years prior to development
starting, both farms had been achieving constant levels of physical
production and were thus assumed to be in a status quo position.

Random Negatives: in both cases small negative cash flows occurred at
random throughout the stream of cash flows. Theoretically these could
have resulted in multiple solutions but in actual practice only one real
solution could be found. It should be noted however, that in other cases
random negatives could lead to multiple real solutions with all their
attendant problems of interpretation.

Money and real values: the analysis of the two case study farms was
carried out both in money and real 1959/60 values. The real values for
income were derived by the use of price relatives (since physical output
was known), and the real values for expenditure were obtained by use of
the New Zealand Meat and Wool Boards' Economic Service Index of Sheep
farmers' Costs. Deflation of the data into 1959/60 values made a
significant difference to the final results.
Windfall Gains: the internal rate of return formulation proved to be very sensitive to windfall gains in the early part of the development programme. In both cases the removal of the Korean War wool boom effect reduced the overall rate of return in money terms by 50%. This highlights one of the basic differences between ex ante and ex post studies of farm development. In the former, windfall gains are neglected but in the latter they may convert an unprofitable programme in real terms into a highly profitable one in money terms. They are obviously even more important in a programme financed by reinvestment than one based on borrowed capital funds.

Residual Values: one of the strengths of a post development evaluation is that a reasonable estimate can be made of residual values at the end of the programme. In these two particular case studies the size of the residual value in money terms was unimportant as the cash flows solved to a very high rate of return but were most important in real terms where they made the difference between a zero rate of return and a profitable rate of return. The other interesting point was that the New Zealand Government Valuation Department heavily undervalued the increase in value of improvements in relation to their cost.
THE ECONOMIC EVALUATION OF INVESTMENT IN LARGE-SCALE PROJECTS – AN ESSAY TO RECOMMEND PROCEDURES*  

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The task of assembling recommendations on the use of project evaluation procedures has been attempted previously. For example, the "Green-Book" has laid a long-respected basis for evaluation work; more recently documents from the United States Senate have emerged as valuable standard references.

Discussions continue at academic levels on both theoretical aspects and the application of discounted flow techniques. In recent years the limitations of discounted flow techniques have been recognised and emphasised, and amid the volumes of literature on this subject there has not appeared, to my knowledge, a simple statement of recommended practices and standards which will materially assist those whose interests lie only in the empirical side of discounted flow techniques. Our experience at Lincoln and the discussions of the Seminar recently completed have forced a realisation of the difficulties facing many who are expected to provide economic information on proposed projects. The diversity of background of those whose duties include economic evaluation indicates that few have been exposed to "professional training" in discounted flow techniques and that they gain small comfort from books and professional journals.

Obviously the lack of a series of uncomplicated recommendations for use at "grass-roots" level exists because it would be considered professionally naive to publish them, even though a writer may have established them subjectively for his own work. In the interests of uniformity, I intend then to be naive, to provide some recommendations which I believe would not be frowned upon too heavily by both respected practitioners and academics, and which probably represent the consensus of informed opinion. No theoretical justification is offered in support, since this would presuppose familiarity

* This paper was prepared consequent to, and at the request of, the Seminar on Project Evaluation. It contains some material already mentioned in the papers earlier in this book, and has benefited from the discussions of the Water Resources, Land Development, and Forestry/Land Development workshops of the Seminar. The contributions by the discussants of these workshops is gratefully acknowledged, also the advice received by Mr R.W.M. Johnson, Professor J.G. Yoho, Mr A.C. Norton, Mr A.C. Lewis and Mr H.J. Flunkett on earlier drafts; all responsibility however lies with the author.
with the theory by many who have not seen the literature, and would complicate unnecessarily a paper which is meant to be free of academic complexities. I fully realise that many may disagree with some of my recommendations, but submit this paper as an interim guideline, until a better one is produced. And this will be welcome. In the meantime, the Agricultural Economics Research Unit at Lincoln College will be guided by these standards for evaluation work commenced in 1968 and later.

The recommendations in this essay refer to the evaluation of large-scale projects - defined for our purposes as projects initiated above the level of the firm; from irrigation projects to reservoirs and so on. The wide range of projects which possibly fit into this category means that detail is impossible in a paper of this nature. The essay considers primarily evaluation procedures in the New Zealand agricultural scene, and is limited to established discounted flow techniques. A working knowledge of these techniques is assumed.

The following topics are dealt with:

1. Objective of the Investigation
2. Scope of the Project
3. Viewpoint
4. Terminology
5. Representation of Benefits & Costs
6. Period of Analysis
7. Discount Rate
8. Index of Overseas Exchange
9. Output Prices
10. Sensitivity Analysis
11. Double-counting
12. Presentation of Results
13. Expected values
14. Re-appraisal
15. Investment & Financing

1. Objective of the Investigation

It is desirable that economic reports be preceded by a clear statement which provides perspective on the evaluation and the reason for the study. This statement should specify the economic facts it is hoped to demonstrate, and the particular decision-making situation to which these facts are appropriate, e.g., some reports are prepared primarily as

1. It should be stressed that the application of discounted flow techniques in "non-agricultural" investment evaluation has been successfully practiced for several years. This essay however, avoids discussion of all but agricultural applications.
methodological demonstrations, others are empirically oriented using established methods; some are basically "research" reports intended for example to demonstrate desirable or undesirable directions of development, others may be intended directly as guides to individual cash investment decisions.

The specific aim of the project should be outlined. For example, one or more of the following may be intended:

(a) to provide information for an accept-reject decision on a particular project,
(b) to compare two or more alternative projects,
(c) to calculate the maximum investment advisable to achieve specific benefits,
(d) to compare different rates or timing of investment.

The prime consideration for specifying the aim of the study should be the question posed to the practitioner, remembering that discounted flow techniques are reasonably flexible and that a slavish adherence to the "usual" procedures of calculations may not produce results in a satisfactory form. If possible the political and social framework within which the decision is to be made should be outlined, as well as the flexibility available to the practitioner in terms of the scale of the project.

2. Scope of the Project

A precise description of the project(s) should be provided. Physical boundaries should be defined along with sufficient technical information to enlighten but not confuse the uninitiated. Technical information may be valuable to later workers in the same area, and if this is likely, it is better retained in an appendix than lost to posterity. Simple maps of project location and boundaries of influence could be included. It is important to signify the relative size of the project and whether or not externalities are likely to be important, and the direction of their influence, even if their effect is not included in later calculations. Any technically limiting factors should be recognised.

3. Viewpoint

Analysis should define and state the viewpoint from which the study is executed.

(a) National viewpoint. The effects of project establishment should in the case of large-scale projects, be traced as far as possible throughout the economy, and will include benefits and costs accruing to the nation as a whole. These are usually evaluated through effects on national income. In the case of
large-scale projects which involve overseas sales and purchases
the national viewpoint should include consideration of the net
effect of the project for overseas exchange. Adequate
evaluation of smaller projects, e.g. drainage schemes involving
a limited number of farmers can undoubtedly be carried out from
the national viewpoint without the inclusion of "spillover" or
exchange benefits.

(b) **Regional or District viewpoints.** These studies include
the effects of the project on regional or district
populations and local governments.

(c) **Industry viewpoint.** The effect on an industry, through
both pricing and production, of the establishment of a
project.

(d) **Individual viewpoint.** The effect of a project on an
individual firm, its operation and profits.

Other viewpoints should be recognised if necessary. Projects
which could involve public money are correctly evaluated from the national
point of view. Studies of farm development are useful from the national
point of view only if some policy suggestions are possible and are given.

It will readily be recognised that some effects of a project may
be benefits from one point of view and costs from another, and vice versa.
Further, some policy questions, e.g. a desirable level of public subsidy,
can frequently be answered only if evaluation is attempted from more than
one point of view.

4. **Terminology**

**Benefits** are defined as the increases or gains in the value of goods and
services which result from conditions with the project, as compared to
conditions without the project. Benefits should be measured net of
indirect and direct costs, and include both tangible and intangible benefits.
They may be classed as primary or secondary.

**Tangible Benefits** - those which can be expressed in money terms.

**Intangible Benefits** - those which are not fully measurable in
money terms, or may not be satisfactorily expressed in money terms, in
formal analysis.

**Primary (or Direct) Benefits** - the value of goods and services
directly resulting from the project less direct and indirect costs incurred
in realisation of the benefits.

2. The definitions of Benefits and Costs are modified and condensed from
my earlier paper. (Paper 4.)
Secondary (or Indirect) Benefits and Spillovers - the increase in the value of goods and services which indirectly result from the project under the conditions expected to occur with the project as compared to those without the project. Secondary benefits and spillovers are measured net of any costs which have to be incurred to realise them.

The simplest solution to the common imprecision of definition of these terms is that spillovers should be acknowledged when a study takes the national point of view, and that secondary benefits occur locally and should be recognised in studies when a local or regional viewpoint is taken.

Costs

Direct Costs - includes the value of goods and services used in constructing, operating and maintaining the project. This category of costs includes all other identifiable expenses, losses, liabilities and indirect adverse effects connected with the project, whether or not compensation is involved, whether tangible or intangible. Costs of investigation, both technical and economic, should be estimated and recorded separately as a cost of the decision making process, but not included in the analysis.

Indirect Costs - the value of goods and services over and above those included in direct costs needed to make the immediate products or services of the project available for use or sale.

Overseas Exchange Benefits & Costs

The net requirement or contribution of a project to overseas exchange is appropriate to evaluation of large projects in the New Zealand economy. Some index of the premium on overseas exchange (at f.o.b. prices) should be applied as a measure of the net social benefits or costs from this source. These benefits could be both primary and secondary and both tangible and intangible.

The terms benefits and costs should be seen as terms which specifically include non-cash allowances. Where these are not included in the study, the terms "benefits" and "costs" are inappropriate. At least four situations, with specific terms describing the flows, can be distinguished:

(a) Individual Viewpoint - Cash Flow Studies - where cash flows only are considered, and the net cash flows are required;

3. Notation used is that outlined in my earlier paper. (Paper 4.)
\[ b_j = \text{receipts or expected receipts} \]
\[ c_j = \text{payments or expected payments} \]
\[ V = \text{present value of receipts} \]
\[ C = \text{present value of payments} \]
\[ V - C = \text{net present value (or private net present value) of project.} \]

This case is similar in effect to the discounted cash flow (D.C.F.) method commonly used by accountants.

(b) **Individual Viewpoint - Including Depreciation or Renewal Funds, or other Non-Cash Allowances**

\[ b_j = \text{income or expected income} \]
\[ c_j = \text{expenditure or expected expenditure} \]
\[ V = \text{present value (worth) of income} \]
\[ C = \text{present value (worth) of expenditure} \]
\[ V - C = (\text{private}) \text{ net present value, or (private) present worth of project.} \]

(c) **Large Scale Projects - Cash Flow Studies** Expected cash flows only, from a regional, industry or national viewpoint, and would include usually only primary benefits with direct and indirect costs:

\[ b_j = \text{returns or expected returns} \]
\[ c_j = \text{costs or expected costs} \]
\[ V = \text{present value of returns} \]
\[ C = \text{present value of costs} \]
\[ V - C = (\text{social}) \text{ present worth or (social) present value of project.} \]

(d) **Large Scale Projects - Including Non-Cash Allowances** Both primary and secondary benefits are included, perhaps with some values imputed or simulated, and with allowances for other factors such as net requirement of overseas exchange:
b₁ = benefits or expected benefits

C₁ = costs or expected costs

V = present value of benefits

C = present value of costs

V-C = (social) present worth or project.

5. **Representation of Benefits and Costs (Income, Expenditure, etc.)**

Benefits and costs included in the calculations should be clearly listed and the method of calculation described - preferably in reasonable detail, in an appendix.

All foreseeable consequences of a project should be taken into consideration. However, the limitations of our techniques demand that the benefits and costs be represented in money terms if they are to enter an economic evaluation. The first problem then is to devise the most satisfactory way of representing the various classes of benefits and costs in money terms.

In large scale projects a broad spectrum of benefits exists - from actual money benefits to intangible benefits. Actual cash flows present no problems of measurement. Similarly, intangibles, by definition, cannot be included in the discount analysis. An indication should be given however of the nature of the intangibles - whether qualitative or quantitative, political or social - and the section of the community likely to be affected. Where the reason is not obvious the classification of a benefit or cost as intangible should be justified by listing the reasons for avoiding measurement.

Between these extremes are benefits which can be represented in money terms with varying degrees of accuracy, comfort and effort.

The synthesis of expected cash flows from both expected technical coefficients (e.g. yields per acre) and expected price and cost figures, is often necessary. The matter of forward estimates of prices for use in the calculation of cash flows is considered later. Preceding papers will have made it clear that small variations in the magnitude and sequence of cash flows may have an alarming influence on the criteria developed for decision making. Every effort must be made to represent expected cash flows as faithfully and as objectively as possible. The following points might aid in this objective:-

(a) Estimates of technical coefficients should aim at accuracy, and the tendency to "play safe" by deliberately incorporating conservative estimates should be avoided. Most estimates of future
production, particularly in the long term, are uncomfortably subjective; using conservative figures does not eliminate or minimise error, but probably ensures its existence.

(b) **Technical change** is characteristic of the agricultural sector, and therefore its incorporation in the synthesis of cash flows is highly desirable if the period of analysis is more than 5 or 10 years. Discounted cash flows would normally compare the "with" and "without" situations; the "without" situation is often mistakenly assumed to be a "status quo" situation. Technical change is an integral part of both the "with" and "without" situations. An estimate of the rate of technical change to be included in the analysis could be obtained from national or area trends etc.

(c) **Input Prices** are constantly changing, usually increasing. If the decision maker is to be provided with a realistic appraisal of an investment situation the observed facts of unit price increases or decreases should be included in the evaluation. If output prices are assumed to be constant, and unit input prices are increasing a "cost-price squeeze" is thereby built into the flows in the same way as it might well be expected to operate in reality. Estimates of unit price increases are available for some types of farming.\(^4\)

(d) **Taxation** should not be included in studies undertaken from the national viewpoint. Mention should be made however, of the likely effect of taxation on the behaviour of people affected by the scheme. Both "before" and "after" tax figures should be presented for studies undertaken from the individual point of view. From the regional viewpoint taxation represents an important transfer to or from the region.

(e) **Depreciation** presents a problem with no unique solution. A recommended treatment, as a simple rule of thumb, of depreciation and replacement costs is as follows - until the project becomes "established" and the new "equilibrium" level of production is obtained, cash flows should include net replacement costs for equipment at the termination of its physical life. After this point the sinking fund formula should be used to calculate an annual equivalent or annuity to represent net replacement costs. This annuity is then accepted as the value of depreciation. If the development period is short, i.e. less than 5 years, the annuity should be calculated for the whole period of analysis.

(f) **Residual Values.** The suggested method of accounting for depreciation in the calculation of flows aims at maintaining the investment intact and in an efficient operating condition. Residual values can as a general rule be ignored, especially in longer term studies, and certainly when flows are discounted to infinity.

6. **Period of Analysis**

If a project is expected to continue for a certain specified time period, obviously this period will dictate the period of analysis and the consequent calculation of cash flows. Many agricultural projects, e.g. drainage and irrigation channels etc., can have an unlimited life if regularly maintained. Further, it may not be possible to forecast at what date structures become obsolete or redundant. The recommended procedure for permanent structures whose life cannot be estimated with reasonable accuracy is:-

(a) calculate cash flows for the development period
(b) capitalise to infinity cash flows which are expected beyond the new equilibrium position.

The termination point of the development period may be difficult to define due to very small changes in the flows, as the new equilibrium position is approached. As a further rule of thumb it will probably be satisfactory to capitalise flows when successive cumulative present values vary by as little as 5.0 - 7.5 per cent.

In long-term projects, there is little difference between the discounted value of cash flows which terminate at infinity and at say 100 years. If, however, comparison is intended with projects of a similar technical nature, which have been evaluated for a given number of years, further results referring to the same time period should be obtained.

7. **Discount Rate**

Amid all the discussion on discount rate, the ultimate decision is usually which rate to use, as long as it is within about 5% to 7%. If the recipients of benefits are specifically those who incurred the costs, the cost-of-capital technique outlined elsewhere (Paper 4) would provide an appropriate discount rate. In other cases, specifically where studies are undertaken from the national point of view, the recommended discount rate is the next lowest one half of one per cent below the monthly average of Government Security yields on outstanding long-term loans at the end of the previous financial year. These are quoted in the Reserve Bank of New Zealand Bulletin in the table "Share Prices and Interest Rates".

Foreign capital should be discounted at the rate of interest on the most recent World Bank loans. This information is usually available from Reserve Bank publications.

8. **Index of Overseas Exchange**

This index is meant to represent the degree of over- or under-valuation of the New Zealand currency. This index would vary from time to time as the economic position in New Zealand vis-a-vis the rest of the world varies. No suitable index can be recommended at this stage.
Reference should be made to the Treasury Department or to the Reserve Bank, if an estimate of this index is required.

9. Output Prices

In historic studies the question of output prices has a self-evident solution. Inevitably actual prices are used. Only when special aspects of historical studies are emphasised should actual output (and input) price be deflated.

In forward looking studies there is no unique solution to the dilemma facing those who require estimates of future prices, particularly over several years. Since both the magnitude of the cash flows and their sequence affect the usual criteria, both aspects must be considered. The disturbance due to output price fluctuations which defines the sequence of fluctuations in cash flows is best overcome by the assumption of a constant price level. If available data show some long term trend in output prices and it can reasonably be expected to continue, this may be included. However, with our present state of knowledge any attempt to forecast the fluctuations in various commodity prices would be unwise.

If we can accept the desirability of using a constant price for forward-looking studies, the next question is the level of the constant price. Should the price be based on past, present, optimistic or pessimistic price levels? Probably past prices are one of the most satisfactory indication of future price levels; on this basis the following are suggested:

(a) for short-term studies (i.e., less than 20 years), output price levels should be the mean of the previous five years' annual average levels;

(b) for long-term studies, output price levels should be the mean of the previous ten years' annual average levels.

If these are not readily available, the Government Statistician's figures should suffice. If the above is adopted there will be little variation in prices between practitioners and between studies commenced in consecutive years.

If reliable long-range projections of prices are available they should of course be used. If production arising from the project is expected to influence prices significantly, the prices with and without the project could be averaged to obtain the price incorporated in the budgets. Ideally a range of prices should be used - this will be discussed in Section 10.
10. **Sensitivity Analysis**

If assistance from a computer is available, practitioners should feel obliged to explore thoroughly the behaviour of criteria over a reasonable range of coefficient values. Recommended areas of analysis are:

(a) The shape of the present value curve (Paper 7), will indicate the sensitivity of present value to the discount rate, and should be explored over a range of discount rates. Does any small change in discount rate materially affect present value? If so, what is the characteristic of the budgeting which is responsible? Should this characteristic be removed or treated in a different manner?

When comparing two or more projects present value curves should be plotted to determine at which interest rate, if any, the present values of the projects are equal. If this occurs, is this discount rate significant for any reason, and what is its relation to the respective internal rates of return?

Simple computer programmes are available or can be written to calculate present values over a range of interest rates. If this range is wide enough the programme will readily show the internal rate of return (or if there are multiple internal rates of return).

(b) The sensitivity of present value to output price levels should invariably be explored. How does present value change with reasonable changes in price levels? At what price level does present value become zero, and is this a price which can be reasonably expected to occur? How far is this price from prevailing price levels? When complementary products are produced, e.g. wool and lamb, the product prices should be varied simultaneously, and by similar percentages, to avoid unnecessary confusion which often adds nothing to the general results. Prices should be varied at units of one per cent to allow comparison with other studies.

(c) The sensitivity of present value to doubtful or critical coefficients. If the derivation of any coefficient has been based on unsatisfactory evidence, or if the coefficient is obviously critical to the study, a full exploration of its influence on present value should be undertaken, over all reasonable ranges of its value. What percentage change in present value occurs from a given percentage change in the coefficient? What percentage change is necessary to
force present value to zero? Input prices, rate of investment, and technical coefficients should be considered for sensitivity analysis.

11. Double-counting

Instances of double-counting have occurred in overseas studies where some primary benefits were counted twice, both as primary benefits and as spillovers. This has not, to date, occurred in New Zealand studies. Benefits should be systematically calculated and every care taken to ensure that no item appears in more than one category of benefit. A common point of confusion relates to the inclusion of increases in land values and income increases. It is not valid to impute to a project increases in the capital value of land which are expected to result from increased income which has already been included in the flows. This would, in effect, be double-counting of the effect of increased income, since land values are related to income-earning capacity.

12. Presentation of Results

The format of results and the criteria developed will depend on the original aim of the exercise. Some general suggestions can be made:

(a) That the evaluation of a project is best made in terms of present values, as the most meaningful criterion. For reasons outlined earlier in this volume (Paper 7 particularly) the internal rate of return has serious disadvantages compared with the present value criterion. Present value, however reflects the size of the project, and gives an unsatisfactory indication of the efficiency of capital. The V/C ratio should be used in conjunction with present value (V-C) if the efficiency or productivity of capital is required.

(b) Comparisons between two or more investments are probably best made in terms of present value. Only if the present value curves (i.e. present value plotted against discount rate) of each investment are known not to intersect at discount rates between either internal rate of return and a reasonable upper limit of commonly used discount rates, can the internal rate of return contribute a great deal to interpretation of results.

(c) Various modifications of the V/C ratio are often useful, when particular aspects of the desirability of the investment require further elaboration. Some of these have been mentioned by Mr Johnson in Paper 9. The V/C ratio refers to the ratio of gross benefits to gross costs, and unless both of these have been calculated
it should be specified that the ratio used is a modification of the usual V/C ratio.

(d) A statement of opinion on the likely magnitude and effect of intangible benefits or spillover effects should be included.

(e) That the values of V-C and V/C be specifically stated in terms of the items included in the calculation, e.g.

- **Primary**: V-C and V/C - including primary benefits only,
- **Secondary**: V-C and V/C - including secondary benefits when calculated,
- **Total**: V-C and V/C - including all tangible primary, secondary, spillover and exchange benefits.

(f) If variations in the scale of the project are possible, results should include conclusions on the "best" scale for implementation.

13. **Expected Values**

If estimates of the probability distribution of possible (e.g. price) situations are obtainable, the analysis will benefit from the calculation of an expected value of the present value.

14. **Re-appraisal**

Reports should be prepared in a manner which facilitates periodic re-appraisal if technical or economic conditions in the years following the original report prove to be significantly different from those assumed in the original study. Rapid changes in markets, or production methods, could make re-appraisal desirable.

15. **Investment and Financing**

Some practitioners, e.g. catchment board officers, must be concerned both with the economic desirability, and the source of finance, of a project. It is imperative however that these two aspects remain separate in the compilation of a report. Any project should be recommended or rejected largely on its economic desirability, and not whether it will appeal to those who may be required to vote for its approval, or whether or not it will make a significant difference to the current burden of rates.
When both investment and financing aspects of a project have to be considered, each aspect should be the subject of a separate report. The investment report will provide information on the economic desirability of the project *per se*, and the financing report will give recommendations on the source of finance.

16. **Policy Conclusions**

No investment study should be considered to be complete unless accompanied by a statement expressing the author's views on the appropriate action which the decision maker should take. Irrespective of whether the study has been commissioned by a government body or a local organisation, it is the duty of the practitioner to weigh all the tangible evidence, advise on this basis, and indicate the weight of intangibles associated with a project. He will be ideally and prominently placed in relation to the project he has evaluated and should advise the decision maker on the alternatives available and the steps he considers appropriate.
1. **The Viewpoint**

A review of procedures for the evaluation of farm development should begin by recognising that there may be a number of different viewpoints. Consequently there can be different acceptable criteria for the evaluation. First we have the farmer's viewpoint. He may be interested in one or more results from his proposed development programme. His interest might be in increased after-tax income, in capital growth, in increased security by building up equity, or in reduced vulnerability by widening the ratio of output to cash expenditure. Alternatively he may be interested in development for its own sake, i.e. provided his standard of living is maintained, he might regard a development programme as successful, when certain levels of physical performance are achieved.

Another viewpoint may be that of the lender of development funds. He will be concerned with the effects of the loan on the development programme, on the security offered and on the ability of the farmer to service the additional debt, immediately and in the long run. If he is lending on current account, his interest will be in the expected profile of the overdraft.

The economist's viewpoint will relate to the fact that the farm development programme is utilising resources (capital, labour, land) which have alternative uses. He will therefore be preoccupied with the economic benefits and costs to the nation.

It is clear then, that for farm development evaluation, we must first establish unambiguously from whose viewpoint we are doing the analysis, and then try to determine the criterion which most accurately reflects this view.

2. **The Investment Process on Farms**

Economists distinguish between different investment processes by reference to the timing of input and output. For example in farming we can recognise the "point-input, continuous-output" case in the installation of bulk grain handling facilities. The "continuous-input,
point-output" case corresponds to the purchase, development and sale of a farm by an investor. But the most common type of farm investment is that associated with a farm development programme. It takes some time to mature, and remains in operation over a number of years. Both development costs and returns are integrated in a series of net cash flows. This kind of investment is correctly classified as "continuous-input, continuous output", and is logically represented by net cash flows, derived from development and post-development budgets, the cash surpluses of which are compared with the pre-development situation. The logic behind the net cash flow concept of farm investment is reviewed in Gow's paper (paper 5). Bonifant's note (p. 167) on the development of the Pakihi reminds us that we will not always be concerned with a situation where the property is already being farmed. However, this presents no analytical difficulty, for it is simply a case of the pre-development surplus being zero.

The net cash flow mechanism gets us tidily around the problem of isolating the capital components of a farm development programme. However, it was pointed out by a number of participants in the Workshop that there was often a need to calculate this capital and express its value in an absolute sense. Those concerned were mainly field officers in departments responsible for farm development programmes. These officers are required to think in terms of a development programme demanding the injection of a specified amount of external capital, over a certain time period, which is expected to result in a certain increase in output, sufficient to service the additional debt, and to yield increased net returns to the farmer. It was agreed by the Workshop that while this approach to the development process lacked the analytical tidiness of the net cash flow basis, and did not usually take into account the cost of time, nevertheless for the specified purposes it met the requirements.

3. Derivation of the Development Budgets

3.1. Pre-Development Budget

The establishment of a valid pre-development situation is not easy. Very few farms are in a stable situation and indeed we know surprisingly little about what constitutes maintenance inputs at various levels of output. Uncertainties with respect to the calculation of the pre-development surplus can clearly have significant effects on the net cash stream. Extreme care must therefore be taken with this budget, and every effort should be made to ensure that it is accurate representation of an equilibrium situation. This will require careful interpretation of previous farm accounts, and close collaboration between technologist and analyst in determining equilibrium input and output levels.

Gow (paper 5) refers to the case established by Lawson for a moving base. This seems logical where the property is already in a dynamic state, (related to the lagged effect of previous
investment) when a new development programme is started. It was pointed out subsequently by Cleland (pers. com) that the rate of return established in such a way is however not a genuine internal rate of return but is equivalent to Fisher's "rate of return between alternative projects".

3.2 Post-development basis

The "project life" problem is clearly an acute one in farm development evaluation, since it has been shown that profitability coefficients are sensitive to this variable. It is acute because of the difficulty in determining the point at which the lagged effects of farm investment are no longer operative. It is likely, for instance that in some studies full allowance has not been made in the post development budget for the stocking capacity created by the previous few year's acceleration of the fertility cycle. Where this happens the post-development budget will not fully reflect the increased productivity, and it will under-estimate the profitability. Indeed it is sometimes rather heroic to draw a sharp line between the "development" and "post development" situations on individual farms. For the eager developer the process is a continuing one as he responds to technological change and to innovations. Nevertheless if we are going to analyse farm development at all, we shall normally have to postulate some cut-off period. Farmers' planning horizons are not usually very long, furthermore the level of uncertainty in respect to prices and technology is high, therefore it is not realistic to compile development programmes for very lengthy periods. On the other hand because lumpy investments, such as buildings and major items of plant are usually very significant in the analysis of development profitability, programmes which do not span the time period within which such costs must be met, are likely to yield inflated profitability coefficients. Thus, the length of the development programme must be carefully thought out on the basis of the development technology, and the post-development budget must fully reflect the level of productivity achieved by the development, if we are going to apply rigorous criteria to the data.

3.3 Treatment of Depreciation

This is fully covered in Gow's paper (paper 5). The recommendation is that both the pre-development and post development budgets must allow full and realistic depreciation rates. It should be noted that, by definition, the post development equilibrium budget should include a depreciation allowance considered adequate to maintain the plant and buildings at a standard which is necessary for the level of productivity incorporated in the budget. This means, that if in the development budgets no actual plant replacement has occurred, the normal "book" depreciation on the written down assets
at the end of the development programme may not be adequate.

In the development budgets themselves, since we should usually be concerned with the farmer's post-tax situation, full allowable depreciation must be calculated for tax assessment. But this will be excluded from the cash flow statement. Purchase of depreciable assets will be brought into the development budgets at their full cost.

3.4 Treatment of Borrowed Funds

If the method of financing the development programme is by borrowing, then from the farmer's viewpoint the borrowed funds represent a cash inflow. Only the debt servicing charges are a cash outflow. The initiation of a development programme financed by loan funds may involve no negative cash flow at all, for example, where the additional revenue generated in the first year of a development programme, by heavy purchases of stock, exceeded the additional costs not financed by the loan.

It should be noted however, that provided the borrowing rate of interest equals the discount rate we are using, the present worth calculation is not affected by the method of financing, or by the timing of loan funds.

4. Criteria and Terminology

4.1 Nation's Viewpoint

The criteria and notation outlined by Jensen (paper 4) in his review of general project evaluation, are applicable to farm development evaluation from the national viewpoint. Our $b_j^a$ would represent annual net benefits when compared with a pre-development equilibrium budget and our $c_j^a$ would not include income tax. The post development benefits should obviously be treated as capitalised income, $\frac{b_{n+1}}{1}$, since the alternative treatment, estimation of salvage value, implies a transfer payment only.

The net present worth (V-C) of the development programme, calculated on this basis indicates whether the programme is "worthwhile" at the specified rate of discount, but does not give the policy maker any indication of how such farm development compares with alternative investment opportunities, for which $\frac{V}{C}$ will be more appropriate.

For the policy maker, the internal rate of return coefficient, established by setting V-C = 0 and solving for the appropriate discount rate, could if accurately assessed, indicate the rate
of interest at which farm development funds could be made available and permit developing farmers to break-even. However, the sensitivity of internal rate of return to variation in technical and financial coefficients and the problems of aggregation mentioned below, suggest that as a policy making instrument for fashioning these kinds of decisions, it is a shaky criterion.

4.2 Farmer's Viewpoint

It is unlikely that any single, tidy, criterion will be adequate in evaluating the profitability of farm development for all farmers. This is because their management objectives vary so widely. Furthermore, even for an individual farmer, assuming him to be an owner-occupier, it is unusual for him to be able to propose an unqualified single objective. Without this, it is unrealistic for research workers and extension officers to assume that their criteria are wholly valid. However it is possible to recognise a number of different objectives which farmers may have in developing their farms, and to suggest appropriate criteria. For example:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance of current standard of living, with increased real income and real net worth in the future.</td>
<td>Post-tax income flow during development and post-development evaluation of (undiscounted) net worth.</td>
</tr>
<tr>
<td>Improved income and net worth position with no greater vulnerability to price falls.</td>
<td>Post tax income flow, post development net worth, and calculation of post development vulnerability ratio (i.e. ratio of gross profit to cash costs including management).</td>
</tr>
<tr>
<td>Acceptable overdraft pattern and &quot;pay-back&quot; period.</td>
<td>Undiscounted post-tax cash flow.</td>
</tr>
<tr>
<td>&quot;Satisfactory&quot; investment.</td>
<td>( V-C ) mutually exclusive projects for comparison.</td>
</tr>
<tr>
<td>Comparative investment opportunities.</td>
<td>( \frac{V}{C} ) independent projects only</td>
</tr>
</tbody>
</table>

4.3 Lenders Viewpoint

Finally it is useful to note in this section that the lender of development funds has two criteria - the ability of the property to meet the additional debt servicing charges, and the enhanced value of the security against which the loan is being made. The lender will therefore use the first
criterion suggested in the above table, where the cash flows are net of the additional debt servicing charges.

5. **Uncertainty**

The level of uncertainty applying to some of the important technical and economic parameters in farm development evaluation is high. It is therefore important that the expected ranges in these parameters be explored in any comprehensive analysis. The sensitivity of results, particularly when expressed as the internal rate of return, to variations in some assumptions was emphasised in contributions to the Workshop. We should rarely be satisfied with an evaluation based on single-valued expectations.

6. **Aggregation**

A feature of results obtained from the evaluation of farm development programmes, even when carried out on similar classes of farms, has been the wide variation in the results between farms. This is only to be expected, for not only do we have variation in the initial resource structure of the farms being analysed, but also differences in the method of financing the development, in the time period over which the programme runs, and most important, in the degree of management skill with which the programme is implemented.

We should therefore be wary of drawing conclusions about the profitability of farm development in general from the results of a few case studies. The problems associated with aggregating results in this way, have been emphasised by agricultural economists working in other fields. It has been demonstrated that misleading results can occur where analysis based on selected units, is aggregated in an attempt to describe a group or region.

However, it is clear that if we want information on the economics of farm development for policy purposes then the only feasible way is to carry out case studies. A more elaborate approach normally would be precluded because of costs. It follows then, that if we require reasonably sound information for policy purposes, our selection of cases for analysis must be as representative and unbiased as we can possibly achieve.
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