A REVIEW OF EVALUATION STUDIES IN
NEW ZEALAND AGRICULTURE & FORESTRY

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A REVIEW OF EVALUATION STUDIES IN NEW ZEALAND

AGRICULTURE AND FORESTRY

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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 (4). Before this, it appears that the conditions were right for take-off (if you will pardon the metaphor). N.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 interdepartmental 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>
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<tr>
<td>Pessimistic Prices</td>
<td>$V_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>Realistic Prices</td>
<td>$V_2$</td>
<td>$C_2$</td>
</tr>
<tr>
<td>Optimistic Prices</td>
<td>$V_3$</td>
<td>$C_3$</td>
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</table>

$V_1$, $V_2$, $V_3$, $C_1$, $C_2$, $C_3$ are the present worths of the respective time streams of project benefits and costs. As might be expected, $V_2 - C_2$ 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 and the limits of benefits in this area examined. The problem of incorporating an existing scheme which becomes redundant is analysed.

While attempts have been made to make these reports as clear as possible, especially with regard to discounting procedures, some 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. 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. The procedures follow those used for irrigation projects. 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. 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 the whole 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 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 (road 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 Agr.</th>
<th>Excluding social costs For.</th>
<th>Including social costs Agr.</th>
<th>Including social costs For.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Future net worth (£000)</td>
<td>3049</td>
<td>4593</td>
<td>1007</td>
<td>2952</td>
</tr>
<tr>
<td>Present net worth (£000)</td>
<td>706</td>
<td>652</td>
<td>233</td>
<td>419</td>
</tr>
<tr>
<td>Land expectation value (£)</td>
<td>28</td>
<td>26</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Internal rate of return (%)</td>
<td>7</td>
<td>6.2</td>
<td>5.2</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) "Waiarea Valley Irrigation" (Mim.) Feb. 1967.


(b) Rural Water Supply Schemes


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


(c) General


2. Catchment Board Studies


3. Farm Investment Studies


4. Forestry Studies


5. General


