Forest Economics: Evaluation for Rural Development [1]

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The allocations of land resources presents one of the outstandingly interesting theoretical and important practical problems of the present time. Man's use of the land impinges on almost every aspect of his existence. Directly it involves the space we occupy for work and recreation, the quality, quantity and price of our food and most of our raw materials, and the level of employment in the primary industries. Indirectly, and not least in respect of forestry, land use decisions influence the provisions of material for further manufacture, the opportunity for employment in processing industries and even the promotion or curtailment of international trade.

The planning of land use can evoke strong emotions, since it implies a possible interference in the relationship between man and the land which may have long family associations. Even beyond this stumbling block, however. any attempt to generalise on land allocation is made difficult by the great range of crop productions that may be technically possible, and among food products alone, by the contrasts that exist between the extremes of excess supply and insufficiency, both internationally and within a single state.

In view of the range of conditions, it is difficult to generalise on land allocation problems, and, as in any display of wide diversity, it is difficult to ensure that the criteria and the methods of analysis are appropriate.

Within forestry the theory of resource allocation, including land development, has been dominated for more than a century by the work of Martin Faustmann (3). The contribution of Faustmann and his contemporary, von Gehren, was remarkable in that not only did it provide the land expectation value concept which served forest economics for a century and more, but it foreshadowed the discounted cash flow principle, rediscovered in the nineteen-fifties (6), that is now advocated for project assessment in industry.

In a form hardly distinguishable from Faustmann's original, the net discounted revenue or net present worth calcul-

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ation has been adopted as the criterion for project assessment by many forestry authors (4, 5, 10). The method allows for the differences in the times at which costs and receipts occur by discounting them to the moment of decision which, in the literature, is usually the present and the begining of the rotation. The essential feature is the adoption of a fixed discount rate, so that the projects under consideration as management options either are accepted when the time-streams of receipts and costs have positive net present values or are ranked in descending positive (or minimal negative) net present value per acre.

As an alternative to the procedure based on an accepted fixed discount rate, the formula may be re-arranged and solved for that rate of interest, the internal rate of return, which equates the time-streams of costs and revenues. Management options that offer rates greater than some critical rate are deemed to be acceptable (the critical rate being perhaps the market lending rate which may be the opportunity costs of the investment, or the market borrowing rate which may be the actual cost, or 'an average long-term rate' which may give answers the analyst wants, or the social rate of time preference, etc.). When the amount of capital investment is limited by a budget ceiling, projects may be ranked and undertaken in descending order until the budget allocation is filled.

There are considerable difficulties associated with the use of net present worth and the internal rate of return as criteria for resource allocation and management in forestry. The discounting period in years features in Faustmann's formula and its derivatives as the power of the discount rate (sums payable or receivable in the future being multiplied by $\mathbf{1.0p^n}$, where **p** is the rate of discount and **n** is the discounting period in years). As the production periods of forests tends, to be long, the calculations of net present worth, and hence the allocation decisions themselves, are especially sensitive to relatively small changes in the discount rate; conversely, large variations in estimated future income may represent such small changes in the internal rate of return as to seem insignificant.

Net present worth calculations may be used reliably for such purposes as choosing between two methods of tending a forest, say by one thinning regime or the other, or choosing between two species that are equally acceptable silviculturally, although it is obvious that the further ahead the calculation looks the more uncertainty is introduced. It is essential for a proper use of the calculation, however, that the object of management should be clear and consistant

with the factor being maximised upon (which is generally true for all cost-benefit analysis), since if one does not know where one wants to go, no-one can select the best way to get there. There is also an important restriction arising from the viewpoint of the manager or investor, to which reference will be made later.

In its most commonly quoted form in forestry, net present worth is expressed per unit of area, variously called the soil expectation value (9), land expectation value (4), and net discounted revenue (5), but it can be expressed per unit of capital committed to the project up to the point in time when the project is financially self-supporting. In this form the net present worth calculation is not distinguishable from the net benifit: cost ratio of cost-benefit analysis. In essence, all the net present worth calculations derived from Faustmann's formula are merely special forms of cost-benefit anlysis, and they suffer from all the general limitations of that group of analyses, even though foresters fondly believe their arithmetic to be infallible, as many undoubtedly do.

The most common major use of cost-benefit analysis has been in the justification of water-resource projects in the United States of America, for which the evidence of a cost-benefit calculation is a statutory requirement if federal financial assistance is to be available (1, 8). It may properly be used to indicate the best option for the lay-out and timing the building of forest roads and similar constructions, and, on a grand scale, one may even make a case for using cost-benefit analysis to choose the site for a third London airport from among five candidates, if one has sufficient information and courage.

Cost-benefit criteria are useful in selecting between management options which will employ a similar set of inputs, but when the choice is between options that do not use the same factor inputs, or do not even achieve the same objective, a cost-benefit calculation may be inappropriate or simply unworkable.

A full cost-benefit analysis will include all the costs and benefits associated with the project, no matter on whom they fall and to whom they accrue. For instance, the benefits of a dam project include not only the power generated, the value of which goes to the hydro-electricity board, but the loch fishing to those who enjoy that, and the protection from flood damage that benefits the farmers downstream. When the project options are simple, it is legitimate to make a partial analysis, since many of the costs and many of the benefits are common to all the schemes under consideration;

alternative forest road lay-outs probably vary only in the direct cost of construction and in the direct benefits of efficiency of extraction and transport, so that it would be superfluous to go beyond these in order to select the best scheme. As projects become more complex, however, the need for more complete analysis becomes unavoidable, since the secondary effects are not common to the options and even the factor inputs which are the primary costs may not be the same.

This last point must be regarded as a serious shortcoming in such work as the report of the Land Use Study Group in Britain (2), since neither the input factors, nor the outputs, nor the management objectives of the forestry and hill farming options were common. The report itself drew attention to the anomaly of the reversed ranking of the options when the criterion of net discounted revenue per acre was used in place of net discounted revenue per unit of capital invested. Although purporting to regard the options from the national point of view, the calculations did not succeed in accounting for the secondary effects of the investments.

In considering a major afforestation scheme, it is not easy to compile estimates even of those direct costs and direct benefits that can be expected, and it becomes very difficult to evaluate the secondary effects of the planting, say on the economy of the hotel industry through reduced woodcock shooting, on the retail and transport businesses and on the processing industries that will eventually depend on the successful timber growing enterprise. The careful critic may find many such project evaluations unconvincing because of their dependence on the evaluation of non-market costs and non-market benefits. In the recent airport enquiries in England, for instance, each project could be made acceptable or unacceptable on the evaluation of noise and the value placed on the time taken for the passengers to travel between the city and the airport.

In rural development schemes in many parts of the world attempts have been made to evaluate forestry and alternative land use by means of cost-benefit analysis or, more restrictedly, by net present worth or net discounted revenue calculations. Many of these are misleading because of a basic misapplication of the methods. Within each study, the common element may be only the occupation of a particular tract of land; the other inputs and even the investment objective may be so different as to frustrate the comparison.

Before making an assessment of profitability, prospective or retrospective, it is essential that the forester should ensure

that the criteria and the techniques he uses are appropriate. Above all this requires that he declare the viewpoint for the analysis and the objective of the management. The viewpoint may be a personal one, say the proprietor of private woodlands, or that of a commercial company, or it may be a regional or a national viewpoint. At the extremes, a net discounted revenue or an internal rate of return calculation is entirely consistant with the personal viewpoint, since the deployment of resources for money profit maximization is meaningful and realistic, and the private individual can identify the point at which his interest in the timber product ceases. For the region or the nation these conditions are not likely to be met, and even the differentiation between costs and benefits may be far from clear; in these instances this type of analysis is unhelpful, although frequently it is used.

How is 'profit' measured for a region or a nation, when its affluence is the sum of the profits and losses of all its citizens? The authorities must be concerned about the size of the regional income and of the gross national product, and more especially about the income per head of the population. (It may be misguided to assume that increased income does mean more welfare and more happiness, but it seems more sensible than other measures). For the region and the nation, the interest of forestry lies in the opportunity that its production of woody material provides for processing industries, not in what has passed as 'forest economics' for most foresters and state forest services, the financial arithmetic of growing trees up to stumpage or forest gate.

It is only since the work of Liontief (7) and especially in the last ten years that a form of anlysis appropriate to the regional and national viewpoints has been available, input-output anlysis. It is still a clumsy tool because of the large amount of data required, but it is with ideas and with the refinement of technique that foresters should now be concerned in forest economics. The analysis requires that the flow of funds through the economy be followed from the initial payment. The expenditure of funds for afforestation means that wages are spent in local shops, and then re-spent by the shopkeepers, perhaps more than once; that a tractor is bought diverting payments to another part of the country; that deisel fuel and superphosphates are bought from overseas, incurringforeign currency debts; that income taxes are paid to the government, and so on. Some of these shares of the initial expenditure are lost to the economic unit almost immediately, especially the taxes which may be leaked from the system by deduction at source, before they are even paid,

while other payments may be used several times, say from the forester to a retail tradesman, and thence to a farmer and to a local garage before finally leaving the region. Input-output studies show the true value of forestry in the economy of a rural area or of the nation, in terms of the contribution to the gross national product.

It is only relatively recently that there has been significant vertical integration of the forest industry from plantation timber growing to the sale of manufactured timber and pulp products. Where this has occured the technical and financial interdependence of the parts is obvious, and the economic principle of the unity of the firm requires that the integrated enterprise should maximise the return from its whole activity. In this there is a clear lesson for those concerned with rural development and resource allocation at regional or national level. If return on capital is the required criterion, the analysis must maximise the return on the whole capital, mill and forest together; a partial analysis may actualy divert management from the desired course.

When the timber of Kaingaroa Forest in New Zealand became saleable in the 1950s, a contract was entered between the Forest Service representing the owners of the forest and the Tasman Pulp and Paper Co. Ltd., giving the company a large volume of timber each year for twenty-five years at the price of 3d per cubic foot. The low price reflected the fact that there was then a large supply and little demand for the wood, that this was a speculative and pioneering venture. The New Zealand government also acquired a large share in the equity of the firm and the appointment of one of the directors, so that the government could have a voice in policy direction, and receive financial return through company dividends as well as from sale of stumpage and taxes on income arising from the development.

Since the start of felling at Kaingaroa there has been intense economic analysis and replanning in order to improve the financial position of the forest grower, particularly aimed at making the next rotation's crop as financially attractive as possible. The pulpwood contract still runs, substantially unchanged, and the stumpage price of 3.75 cents per cubic foot (the decimal version of the original) is used in forward net discounted revenue calculations, together with rather high prices for saw-log assortments. The management guidance is clearly directed towards a low input system with very wide-spaced trees and little thinning; pulpwood would be produced form the sawmill residues and, mainly, from the knotty tops of the trees which provide butt-length saw-logs. The pulpmill engineers believe this type of material, especially the knotty

top lengths will be technically inferior to pulpwood grown for that purpose in a relatively high input system; although low-priced, the knotty pulpwood may be a high cost material in terms of mill-processing, particularly in 'down-time' of machines from paper tears which are serious in a fast, continuous production process, and in the quality of their final product which has to compete on the world market.

The true merits of the types of pulpwood and the effect on the mill production are somewhat speculative, but it may be fairly said that insufficient is known about the relationship between production functions in processing industries and the quality of the wood that is their raw material. This lack of understanding may be put down partly to the difference in the time horizons of foresters and mill managers and industrial financiers. The latter have relatively short views, and they are interested in the material that is available now; they accept its quality because it is beyond alteration. The technical possibilities of changes in forestry production in the medium to long term in a resource that does not belong to them tend to be unheeded.

The economics of scale in the pulp and panel industries, and in saw-milling also, are such that it seems inevitable there will be continuing increase in the size of processing plants. This implies that the mills will be increasingly vulnerable in respect of interuptions in the supply of raw material, and the managers of the mills must inevitably react by seeking vertical integration with the wood suppliers. Proprietorship implies the control of the management decisions and, in forestry, this means control of the rate of exploitation and determination of the technical quality of the wood produced.

It is therefore pertinent to question the future position of state forests where the state does not own the processing mills. The 'classical' European situation of a communal or state forest supplying processors or consumers who were all small in relation to the wood producing unit has now all-but vanished. The foresters' persistence in planning with net discounted revenue calculations based on stumpage or forest gate sales has masked the fact that forest proprietorship (at least in terms of effective control of management and realization decisions) is rapidly passing to the mill manager. Indeed, the proprietorship of the forests may be much less important than that they contribute most effectively to the whole forestry sector, even if this means state forest proprietorship passing to mills. The situation might require safeguards against spoliation of the forest by a ruthless miller, including inadequate regeneration, since the forest conveys

benefits to society other than wood supply, but reversion of proprietary rights to the state and sanctions could be written into an agreement. It seems probable that something like the British Columbian tree farm licence system, but applied to plantation forestry, would meet the requirements of management and would safeguard society's needs.

There appear to be only two possibilities: that the forestry proprietors, whether public or private, enter the processing industries: or that the large processors become the **effective** forestry proprietors. In several countries the first option is being taken, mainly through co-operatives or associations of private forest owners, as in Norway, but this generally leaves state forestry where it is, certainly so where the government denies the forest service the right to invest in private commercial enterprises.

In the long-run supply of wood for processing, and this is where the techniques of resource appraisal and the effects of viewpoint and proprietorship come together, one of the most important decisions is the location of the forests relative to the supplying mills. From society's viewpoint the effectiveness of wood-supplying forests varies greatly according to their proximity to the mill which they serve. When it is remembered that 65 to 85 per cent of the mill gate price of timber is incurred in the 24 hours before delivery, in felling and transport costs, minimization of transport costs usually provides the most effective way of reducing the cost of the raw material. The important thing, however, is the acceptance of the principle that the whole operation of growing, transporting and processing wood is one exercise in forest economics, certainly when viewed from the regional and national viewpoints.

This is the principle lesson that is emerging from forest economics in relation to land development. The interest in the micro-economics of forestry is diminishing as wood growing is seen as part of a larger industry. The future requires investigation of the inter-industry relations of forestry so that the forest planner may see the contribution that major management decisions make to the welfare of society or to some representation of that welfare, such as the income per head of the population. For purely internal management requirements, the net discounted revenue calculation still remains the most powerful tool, but the emergence of input-output analysis for development planning, it will have a restricted role.

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