

# IRISH FORESTRY

---

Volume 25

SPRING 1968

Number 1

---

## The Basis of Forest Planning

D. R. JOHNSTON, B.A.

### *Summary*

The broad field of planning is subdivided into four main aspects — basic principles, basic considerations, planning procedures and the methods or tools of planning. Many of the difficulties of forest planning are due to imprecise or incompatible objectives and to inappropriate criteria of success. It is a basic principle that there should be one main objective with the subordinate objectives expressed as constraints. The most important considerations are that plans should be initiated at the right level of management and that they should be completely flexible. The logical planning procedure is to analyse the current expenditure in order to find where economies are most likely to be effective and then to investigate more closely whether the level and the nature of the investment is in accordance with the management objectives. There is a tendency to use simple drillbook planning guides at the lower levels of management and more sophisticated operational research techniques at the higher management levels.

### INTRODUCTION

In a discussion on planning there is a serious risk of confusing relatively simple ideas merely because the words which are used to describe abstract concepts do not always mean quite the same thing to different people. It is, for example, almost impossible to define in a mutually exclusive way the meaning of the words *planning*, *management*, *administration* and *organisation*. Nevertheless it is possible to make a simple and commonsense differentiation between planning on the one hand and management, administration and organisation on the other. Planning may be thought of as the process of deciding what to do while management, administration and organisation are words used to describe various activities which are concerned with the implementation of plans.

It is even more difficult to differentiate between policy-making and planning. There is, for example, a tendency for the planning at one level of management to be regarded by subordinate levels as policy-making, and vice versa. But the difficulty may be overcome by considering instead the formulation of objectives which can conveniently be thought of as the end of policy-making or the beginning of planning at any particular level in an organisation.

As a matter of convenience in presenting this paper the broad field of planning is subdivided into four main subjects as follows:—

- (a) Basic principles.
- (b) Basic considerations.
- (c) Planning procedures.
- (d) Methods or tools of planning.

This series from (a) to (d) may be thought of as a progression from more abstract to more practical considerations or alternatively as a sort of chronological sequence which is followed consciously or unconsciously in a planning exercise. Thus the basic principles have to be considered first. The procedures of planning cannot be evolved until the basic considerations of planning have been clarified and at the final and most practical level the tools of management are used within an established planning procedure.

### BASIC PRINCIPLES

#### *Objectives and Constraints*

Much has been said and written about the technical difficulties of planning a long-term enterprise like forestry but there is much to support the view that the greatest difficulties arise not from the vagaries of nature or from the uncertainties about future events but rather from uncertainties in the minds of the planners and managers about what they are really trying to achieve and how they should assess whether or not they are succeeding. Many of the purely practical or technical problems in forestry, or in many other activities for that matter, tend to disappear if the objectives are clearly defined and clearly stated.

It frequently happens that a forest enterprise has a number of different objectives not all of which may be compatible. For example, the objectives might be stated as follows:—

- (a) To earn the highest profit.
- (b) To provide employment in rural areas.
- (c) To preserve the native fauna and flora.
- (d) To preserve or improve the beauty of the countryside.

As a series of general aspirations there is nothing wrong with these statements but as a basis for planning they are of little value. It is extremely likely that any measures to achieve objectives (b), (c) or (d) will compromise the achievement of (a). Before planning can start therefore it is necessary to choose one main objective and to introduce all the other subordinate objectives as constraints. Thus in the example quoted above the objectives might be restated as follows.

To earn the highest profit subject to the following constraints.

- (a) Employment is to be provided for x workers.
- (b) X acres are to be set aside as a nature reserve.
- (c) On y acres the main objective is to be the preservation of beauty rather than the attainment of profit.

Clearly, the constraints will tend to be expressed in qualitative

terms at the highest level and in quantitative terms at the lower regional or forest levels where the dilemma of the local staff can only be resolved if they are given a well defined objective with the constraints clearly defined and, whenever possible, in quantitative terms.

The only valid basis for adopting a particular plan is that it will achieve the policy objective more effectively than any other course of action. It follows, therefore that the policy objective itself is fundamentally the criterion by which the effectiveness of a course of action should be judged. Policy objectives, however, are often expressed in somewhat vague terms such as "the attainment of the maximum profit". First of all the objective has to be restated in unequivocal terms. The expression "maximum profit" for example can mean a number of different things and it is necessary to specify precisely what is meant by profit before it is possible to plan logically for its achievement. It is most important that a particular investment criterion such as maximum net annual income, maximum financial yield or maximum net discounted revenue using a discount rate of 5 per cent should not be chosen until the full implications of adopting it have been considered. But even when the objective has been expressed in precise terms it still remains an abstract concept which cannot be recognised in the forest. It is therefore necessary to find physical indices such as planting distance, thinning intensity or rotation age which are closely correlated with the abstract criterion and which can be recognised in the field. Failure to adopt a criterion which properly reflects the objectives and failure, in turn, to relate the criterion with closely correlated physical indices results in a great deal of misdirected effort. This may be illustrated by an example from a European country in which forestry is controlled by various official regulations which may be regarded as analogous with the physical indices mentioned above.

Over the years the more accessible forest in this region has been overcut and overgrazed and as a consequence it has degenerated into a relatively valueless coppice. But in the more remote, mountainous regions communications are poor and much of the forest had never been cut before 1946. As a result of relatively light cutting after the war the less inaccessible forests have tended to assume a two-storied structure with a light understorey of younger regeneration and a heavier over-storey of overmature trees. The stated intention of the forest enterprise is to practice fully commercial forestry but there is, or was, a regulation which restricted the cut to the current annual increment. An elaborate inventory has been undertaken with the principal objective of determining the current annual increment which thus determines the cut. Since most of the growing stock is very overmature it has an extremely low annual increment and it is suppressing the younger and potentially more vigorous regeneration. Clearly the cut should be far greater than the current annual incre-

ment for a period of several decades both to exploit the high capital value of the very slow-growing overmature trees and to encourage the younger regeneration which will have a much higher annual increment. The obsolete regulation has not only resulted in a form of management which is at variance with the stated management objectives but it has also resulted in a somewhat misguided inventory. There is little value in knowing the current annual increment of these forests. Interest should rather be centred on the volume of overmature timber, the length of time it can be expected to remain healthy, the progress of regeneration and so on. Under the present circumstances the principal aspect of the inventory is of only academic interest. The same country provides another good example of a regulation which is incompatible with the management objectives. There is a surplus of beech in the mixed forests and much of it is of bad form. From an economic point of view therefore it is desirable to reduce the proportion of beech in the stands and to remove the genetically poor specimens. There is a regulation, however, that any tree which is felled must be harvested. Since the demand for firewood is diminishing and the average haul from stump to road is long the foresters have three choices open to them. These are first, to fell and extract the tree at a considerable loss, secondly to leave the tree standing to the detriment of future profitability or thirdly to fell the tree but not to extract it thereby risking a substantial fine. Fortunately the illogicality of these regulations is being realised and steps are now being taken to repeal them.

A former British Colony provides another example of management rules which were incompatible with logical policy objectives. A few years ago this country was short of capital for development. In a particular region there is an area of natural but somewhat degraded forest. This type of forest can be considerably enriched by the simple process of clear-felling because the more valuable species regenerates more successfully than the other less valuable species in the forest. The local criterion of management success was that 1/70th of the forest area should be felled annually. This, it was estimated would ensure a permanent and consistent yield from the area on a rotation of 70 years. There were at the time two local sawmills but the planned yield was only sufficient to keep one sawmill going at about 60 per cent capacity. It was apparent that this country required a fully commercial forest policy and that the cut should have been increased sufficiently to keep both sawmills fully occupied whenever markets were available. The area would then have been cut over, and in the process greatly enriched, in about 20 years instead of 70. Even if there had been no further supplies of raw material for several decades the sawmills would have justified their establishment costs but there were in fact young plantation which were coming into production within about twenty years.

These practical examples show clearly that the physical indices

such as spacing, thinning regimes or stand maturity which are used as practical applications of an economic criterion have to be chosen with care. Two factors have to be considered. These are technical efficiency and convenience. Considering the familiar problem of crop maturity as an example, rotation age has several advantages over average tree girth as a practical index of economic maturity. In the first place it is much easier to read off a year on a calendar than to find the average girth of a stand of trees. A more important factor however is the extent to which the physical criterion and the management objective are correlated. Average tree girth is very much influenced by such factors as initial spacing and the thinning regime but girth is less closely correlated with profitability than is age. In other words an increase in thinning intensity or a change in the type of thinning may change the average girth by, say 20 per cent but the optimum rotation age by only, say 5 per cent. Finally, if maturity is specified as an age rather than as a girth the forecasting of future production is greatly facilitated.

#### *BASIC CONSIDERATIONS*

There appear to be two overriding considerations in forest planning. These are first, the level at which planning is carried out and secondly the flexibility of planning.

##### *The level of planning*

It is often easier to explain what should not be done rather than what should be done. It has been traditional in forestry to write forest working plans. These developed in the 19th century and their whole concept reflects the stability and assurance of 19th century Europe. Transport in general and the transport of wood in particular was slow and cumbersome so that the management of an individual forest tended to be geared to the social and economic life in its immediate neighbourhood. Under these circumstances it was logical to consider a forest area in virtual isolation and to plan accordingly. Today forests are no longer isolated. Forest industries are large and transport is relatively easy. Therefore one forest may supply many industries and one industry may be supplied by many forests. Moreover technological development is rapid and Governments, in general, interfere more and more in the economic life of the country. Under these conditions it is clearly illogical for each forest manager to make his plans in isolation. This means that the forest working plan can no longer be regarded as the basic planning document.

The dominant forestry activities vary according to the circumstances of the forest enterprise. In a developing country they might be the construction of a harvesting and transport system and the establishment of forest industries. In a developed country the dominant activities may be harvesting or planting. The dominant constraints are nearly always the availability of capital and know-how. Almost all forestry activity ultimately stems from these dominant

factors. Therefore planning must inevitably be initiated at the management level which controls them, and it must spread downwards through successive management levels to the forest.

In a large forest enterprise there are several levels of management each of which has a planning function. At each successively lower level the plans become less wide and more detailed.

At the highest level, for example, the planner considers all aspects of forestry including the numbers and types of staff required, their remuneration and conditions of service, the administrative organisation and so on. Lower levels of management are not responsible for many aspects of staffing nor for such matters as the level of forest investment and the marketing policy or for the relationship between forestry and other forms of land use. They are concerned rather with implementing an imposed programme within an imposed budget.

As one illustration let us consider the planning role of a conservancy in a country like Gt. Britain or Ireland. The conservator has little or no authority to make fundamental changes in the professional or technical staffing. He is likely to be allocated a planting and harvesting programme based upon the physical resources of his conservancy but determined also by the national forest needs.

There are, broadly speaking, two ways of dealing with this situation. One is to invite proposals from districts or forests and then to juggle with these until they add up to the conservancy requirement. This is time-consuming and inefficient and is rather like asking a number of builders to start work on a building without giving them a plan. The other is to consider the physical resources of the conservancy as a whole and to allocate the basic programmes — usually planting and production, to the various districts or forests. This provides a quantitative framework within which the subordinate manager can work. It is also necessary, however, to define a financial framework because there is a very large range in the level of management intensity which local managers may consider necessary for the implementation of the basic programme. The conservator has therefore to give guidance on such matters as cleaning, draining and protection.

It is a pure coincidence if the sum total of the plans initiated at one level of management happen to add up to a desirable plan for a higher level of management. It follows therefore that the preparation of forest working plans is likely to be a time consuming, frustrating and largely academic exercise unless they are preceded by a regional or conservancy plan which defines the broad qualitative quantitative and financial framework within which they have to fit. By the same token a number of regional plans are of limited value unless the place of the region within the national policy and the national targets has been clearly defined.

#### *The Flexibility of planning*

It is often said that the late 1940's and the 1950's was the age

of planning and that planners have so frequently failed to forecast future trends that planning itself has become discredited. At the national level we have seen the development of various concepts of planning. At the one extreme some communist countries attempt, in effect, to determine economic development by laying down in advance exactly what is to happen for several years ahead. These are known as definitive plans. At the other extreme indicative national plans are no more than forecasts of future trends published with the idea of providing information for private industry and commerce. The F.A.O. timber trends studies are good examples of such indicative forecasts. There is no doubt that long-term forecasting is very uncertain; consequently there has to be an increasing interference with the natural economic processes if definitive plans are to be made to work. It follows therefore that the difficulties of long-term definitive planning are most likely to become apparent in countries with a mixed economy. In such countries the free market sector of the economy acts as a control against which the extent of the fiscal and economic measures necessary to ensure the implementation of the long-term plans may be measured.

Foresters have realised the purely technical difficulties of long-term planning for a very long time and their attempts to impose formal management patterns upon their forests have continually been frustrated by wind damage and regeneration difficulties. But more recently forestry, in common with other industries and other activities, finds itself increasingly involved in the complex economy of a modern society. Physical problems like wind damage and regeneration therefore no longer dominate forest management. The forester today is equally or perhaps more concerned with market developments, changing fiscal arrangements, social problems and a rapidly changing technology and unlike the powerful central government of a planned economy he has no power to make arbitrary adjustments to the economy in order to fulfil his long-term plans. It may therefore be concluded that, for a variety of reasons, longterm, detailed forestry planning is likely to be not only a waste of time but a positive hindrance to logical decision making.

On the other hand forestry by its very nature demands a long-term view. It is therefore something of a problem to reconcile a long-term view with the needs to adapt management to changing conditions. Almost every action that a forester takes will initiate a train of events that will take many years to complete. When a forester plants a tree, for example, he is, in effect, planning for sixty or more years ahead. Therefore the forester has to be clear about his long-term objectives although he must recognise that subsequent events may render them obsolete. In general, however, the basic objectives, if carefully defined, will change less rapidly than the methods used to implement them. Technology changes more rapidly than policy and the physical environment is always relatively unpredictable.

Fundamentally the solution to the planning problem in forestry is not difficult. It is simply to ensure that planning is completely flexible at all levels. That is to say that as soon as a situation has changed the plans should, if necessary, be changed accordingly. At first sight this may appear to be a somewhat irresponsible statement. It could be interpreted to mean that a longterm activity is to be subject to the whims of every successive planner or manager. It is clearly illogical however to persist with any plan after circumstances have altered sufficiently to change either the objectives or the optimum methods of achieving them.

A reasonable degree of continuity can usually be assured by ensuring that plans are initiated at the right levels of management. The greatest risk of confused and inconsistent management arises not from continual adaptation to changing circumstances but rather from the initiation of plans at the wrong level of management. Much of the confusion which arises from time to time in forest management occurs when subordinate levels of management introduce changes in policy when their function and perhaps their intention is merely to introduce changes in technique. It is obvious that this is more likely to occur when the objectives of the enterprise as a whole have not been stated clearly and unequivocally. The treatment of mixtures can provide an example of inconsistent management. In the absence of a clear objective one manager plants a hardwood crop with a conifer nurse. A succeeding manager with an amenity or sentimental objective removes a large proportion of the conifers, a third manager with an economic objective removes the hardwoods while a fourth with the object of realising capital in order to balance a budget clear-fells the crop prematurely. All these changes in management could have taken place without the basic management objectives of the enterprise having changed at all.

If forest planning is to be flexible it must be a continual process intimately bound up with the administrative and financial procedures of the enterprise. Some formal machinery is necessary but the traditional forest working plan has little place in the planning process. It has already been said that at successively lower levels of management planning becomes less concerned with formulating policy and more concerned with implementing it. It has also been said that policy changes less frequently than technology and practise. Therefore, in an age of rapid technological change there is little advantage and not a little danger in committing to paper detailed methods of working for more than a very short period ahead. Moreover methods will change not only because of technological developments but also because of new information and an increasing awareness of the economic implications of forest operations.

Stripped of all the inessentials the forest working plan thus consists of the basic management data on the forest estate; such as the growing stock, the labour force and the various types of equip-



ment, all expressed in tabular form, a forecast of future work for, say, five years ahead, a budget for the current year and a budgetary control system which enables the forest manager to exercise an adequate control over the year's work. The planning and technological development which lie behind the forecasts and budgets are dynamic processes which are going on all the time. They should not be crystallised into formal documents.

It has already been said that planning should be a continual process. Nevertheless it is desirable, periodically, to make a thorough review of the plan for a management unit whether this is a forest, a district or a region and a major review of this nature provides a convenient basis for a discussion of the procedures of planning.

When undertaking such a review it is a useful preliminary exercise to summarise the total expenditure within the management unit in several ways. Expenditure outside the control of the management unit under consideration should normally be ignored.

One way is to summarise the total amount of money being spent on each of the basic resources of forest labour, foresters, office staff, professional staff, machinery, materials and buildings. This form of summary may be modified to give the total cost of overheads at each level of management. A quite different approach is to consider the total amount of money being spent on each of the forest operations such as planting, weeding, cleaning, estate work and so on.

Reviews of this type help to put the planning problem in perspective and to focus attention on the more important sectors. If, for example, fifty five percent of the total budget is being spent on forest labour, thirty percent on local supervision and five percent on machinery, one wonders whether there is too much supervision and too little mechanisation. If in the forest operations account fifty percent of the total budget is going on weeding and only, say, eight percent on planting it will very likely be more profitable to utilise work study, management and research resources in reducing the cost of weeding than in achieving economics in planting.

Although a preliminary review of this nature may show up inefficiencies and inconsistencies in the current use of resources it will not show whether the overall directions or intensity of the work is consistent with the objectives of the enterprise. It is therefore also necessary to investigate the possibilities of changing the level of the investment or the nature of the investment in forestry. It may be more profitable for example to switch part of the investment from new planting to the fertilising of pole stage crops or to reduce the intensity of investment by abandoning brashing, thinning, draining and roading.

In order to undertake this type of investigation, whether it is done with the aid of a paper and pencil or a computer the planner has to follow a logical procedure which may be summarised as follows.

- (a) to define (or recognise) the objectives.

- (b) to identify (or recognise) the constraints affecting his freedom of action.
- (c) to adopt an appropriate criterion of success.
- (d) to consider the possible courses of action.
- (e) to assemble the relevant information on costs, prices, physical responses and so on.
- (f) to test against the appropriate criterion the results of following different courses of action.
- (g) to make the final decision.

In theory this appears to be a logical and straightforward procedure even if the calculations, may under some circumstances, be very complex. In practise, however, it is often difficult to define the objectives and constraints unequivocally. These must logically precede mechanics of planning but the investigations and calculations made in the course of planning may reveal that the objectives are unrealistic or the constraints impracticable or too expensive.

It is therefore possible to recognise a distinction between planning and decision making even if both functions are performed by the same person. Or looked at in another way the word *planning* may be understood to embrace both the testing of various courses of action against the appropriate criterion and also the final decision making. As well as requiring an opinion on uncertainty, decision making may also involve a reappraisal of the original objective and constraint. This is something which we all do every day often without realising it. For example, a man may set out with the object of buying a boxer dog with the constraint that it shall not cost more than £12. When he gets to the pet shop and finds that the cheapest boxer puppy is £20 he may relax his constraint and pay £20 or he may change his objective and buy an Alsatian puppy for £12 or he may decide to have a cat instead.

In practise it is the constraints rather than the objectives which are most likely to be uncertain. For example, in a depopulated region the objective may be to earn the highest profit subject to the constraint that employment is to be provided for, say, 200 men. If, however, it is found that the highest profit could be earned with a labour force of only 50 men this constraint might well be reconsidered.

In a large organisation considerable inconsistencies and inefficiencies can result when national or regional objectives and constraints are changed at subordinate levels of management. This often happens unwittingly when field practices are introduced locally, without a full realisation of their implications. This underlines the necessity for defining clearly and unequivocally the objectives, constraints and criteria. If this is done the execution of plans can safely and with advantage be decentralised as much possible.

It is sometimes said that planners should consider all the possible courses of action. In practise this is rarely possible although a large number of alternatives can be tested with the aid of the more

sophisticated linear and other programming techniques if a computer is available. Most forestry planning, however, depends very much upon the experience and the imagination of the planner and the number of alternative courses of action which can be investigated is small. It is necessary, therefore, for planners to make a conscious effort to free themselves from prejudice and convention and to be prepared to consider courses of action which at first sight may appear to be unpromising or impracticable.

#### *METHODS OR TECHNIQUES OF PLANNING*

The basis of planning is commonsense and judgement but except in the most simple or familiar situations it is impossible for the human brain to see through the implications and interactions of the factors involved. Various aids are therefore required to help the planner.

But despite the rapid growth of analytical aids, or tools, in recent years their use cannot absolve the manager from using his judgement. There are two principal reasons for this. One is that it is difficult to collect all the relevant facts. The other is the difficulty of knowing how to handle those factors of the situation which are uncertain. This means that the manager is necessarily left with the task of making judgements about such matters as future economic conditions and their effects on the enterprise.

A plan attempts to mirror a real life situation but most day-to-day planning is based upon extremely simplified, rationalised and short term data. Highly sophisticated methods are required if a wider range of factors, a deeper consideration of interactions and a longer term view are to be taken into account.

It is possible to classify planning aids in order of increasing complexity or sophistication and Table I<sup>1</sup> sets out such a classification.

The order from 1 to 5 can be associated with:

- (a) a declining degree of compromise with and simplification of the situation;
- (b) a use of increasingly complicated, yet more flexible tools;
- (c) increasing realism and improvement of the overall result;
- (d) a change from "ready-made" to "made-to-measure" solutions.

#### *Drillbook guides*

Leaving aside techniques which rely purely on habit and experience and which may be regarded as special types of drillbook solutions, it is probably true to say that most planning in forestry today depends upon the use of various tabular and graphical aids, reference charts and standard drills.

Volume Tables, Stand Tables and the Management Tables of the British Forestry Commission are good examples of drillbook guides which provide answers to problems without the need for any calculations on the part of the user.

Table I. A Classification of Planning Techniques

Technique	Approach	Application in forestry	Examples
1. Past experience or habit.	Conventional solutions, allowing little adjustment to the realities of the situation.	Widely used as the basis of most local management decisions.	Choice of species. Sowing densities, planting distances, layout of drains.
2. "Drillbook" solutions from manuals, standing instructions, etc.	Intermediate.	Becoming more widely used.	Setting of piece-work. Profitability calculation.
3. Ready reckoners.	More flexible, recognising the realities of the situation but using a repeatable technique of analysis.	Used only for major problems, normally at higher levels of planning.	Allocation of national planting programme to regions. Cutting plans to meet mill requirements.
4. Operational research, that is broader analysis reviewing a number of courses of action and possible interactions within any one.			
5. Comprehensive study of all feasible courses of action and foreseeable consequences.		Rarely used as yet, dependent on ability to exploit operational research techniques, applied at higher levels of planning.	

*Ready Reckoners*

A ready reckoner may be regarded as a more sophisticated version of a drillbook guide. Much of the information obtainable from a ready reckoner is derived from calculations built into the system but the user is required to make various assumptions and to undertake relatively simple calculations in order to find the answer to his particular problem. There is no clear-cut distinction between drillbook guides and ready reckoners. The difference is one of degree. Standard-time tables which are used for setting piece-work rates are a good example of a more highly developed drillbook guide or a simple ready reckoner. These tables give the standard minutes required for a particular job but they also enable the standard time to be adjusted in order to make allowance for local conditions. Ready reckoners are used by the British Forestry Commission for various types of profitability calculations.

*Operational Research*

While drillbook solutions and, to a lesser extent, ready reckoners provide examples of ready made solutions of recurring problems, operational research is used to uncover the interrelations among a whole variety of factors. It may thus be regarded as a fully made-to-measure technique of planning and the term "operational research" is usually restricted to investigations which take account of a large number of variables and consider a wide range of possible courses of action.

*A comparison of the various techniques*

It is clear that each of these techniques has a place in forest planning and with a wider recognition of the need for planning from the top downwards operational research techniques must inevitably become more widely used.

The relative roles of drillbook guides and ready reckoners is less clear. Very many minor decisions are made in the forest but it is unlikely that the foresters and forest officers who make these decisions will have the time or opportunity or even the inclination to make use of a pencil, paper and a slide rule every time they are faced with a problem. Moreover, the use of a ready reckoner often involves the user in making assumptions and this may be difficult or uncertain. Basically, drillbook guides are used to ensure that all decisions are somewhere near the optimum whereas a ready reckoner is intended to assist the planner in approaching more closely to the optimum. It is probably better to ensure that most decisions are fairly good than that some decisions are very good. For this reason it seems that rather more effort can usefully be put into the preparation of drillbook guides than of ready reckoners.

An example of this is provided by the ready reckoner which was evolved by the British Forestry Commission for the calculation of optimum road density. In order to use this ready reckoner it was necessary to make several estimates including the unit cost of moving

produce from stump to road and the factor representing the relationship between the road density and the average skidding distances. These two assumptions were often so unreliable that the answers obtained from the ready reckoner were often of little value. Therefore the ready reckoner has now been replaced by a drillbook guide. In order to use this guide one has only to decide on the proposed extraction technique, the soil conditions and the road cost per mile. The drillbook guide is more widely used than was the ready reckoner and the result has been to reduce the previously accepted roading densities by a considerable extent.

1. Johnston, D. R., Grayson, A. J. and Bradley, R. T., 1967, *Forest Planning*. Faber and Faber.