

# IRISH FORESTRY

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## **PRACTICAL ECONOMICS OF FOREST OPERATIONS**

### **WITH PARTICULAR REFERENCE TO OPERATIONS ON A PIECE-WORK BASIS**

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The world to-day is passing through an era of economic and financial consciousness. International and national opinion is well attuned to the pleas of the economists and financiers for increased production, reduced costs of production, increased savings, etc. High sounding alphabetically-distinguished organisations have been evolved to cope with the inherent problems that exist in the various fields of economic endeavour. No less than many of the more publicised industries and enterprises, does forestry take its place in the deliberations aimed at the achievement of such desirable objectives as the "stabilisation of world economy," "the closing of the dollar gap," "the balancing of internal payments," "the increasing of the standard of living" and other worthy objects. Of forestry it may be said that a vigorous policy pursued to the ultimate in all its varied aspects, would most certainly embrace some feature of all these objectives. On no other commodity is the economy of a nation more dependent than on timber. In all branches of industry, both primary and secondary, it is an essential component. In the domestic sphere it is no less important. It has reached the position there where its usefulness and occurrence have been taken for granted. Familiarity has, in fact, bred contempt. Investigations therefore into problems of forest economy bear, even though indirectly, far more on the everyday lives of the people than is appreciated.

An appreciation of the fundamental principles of forest economics is a pre-requisite to any study of their application to forestry practice. From the very nature of the industry in itself, being a series of operations and activities spread out over a large number of years, diverse problems of economic theory are presented. The slow maturation of trees coupled with the fact that income is periodic, renders normal concepts of profit and loss inapplicable to forestry investments. The simplest concept of a forestry investment as applied to any single plantation is as follows. If all items of income and expenditure from planting to felling for any particular plantation are known, a rate of interest can be worked out which, when used to carry forward at compound interest all items of expenditure and income to the time of felling will, at the

end of that period, balance both sides of the account. This rate of interest is the rate earned on the capital invested in that particular plantation. While this concept is not the "be all, and end all" of forest economics, it is nevertheless a most useful concept for practical purposes, and should always be borne in mind. It will serve to emphasise in the minds of both the administrative and the practical forester alike the very practical importance of the impact of compound interest on the operational set up. £1 spent to-day will at, say, 4% amount in 20 years to £2.2; in 40 years to £4.8, and in 60 years to £10.5. Conversely £1 of income to-day will accumulate at 4% compound interest to the same figures for the same periods. Over-expenditure then, in the early stages particularly, or at any period during the rotation, will have a cumulative deleterious effect on the investment as a whole. Conversely, with income a cumulative beneficial effect is obtained as a result of any increase in returns.

Economic forestry is not, however, merely a question of making forestry pay for its own sake. Forest produce is in fact only the raw material for a variety of industries. This raw material is utilised in the manufacture of wood goods and products. If these goods and products cannot be produced at prices competitive in world markets, then the purpose of the industry as a whole is negatived. The fundamental prerequisite of the effective achievement of a competitive price for such goods is the production of the raw material at as low a cost as possible. This can only be done by a sustained and determined effort towards economy in forest operations throughout the rotation. The economics, then, of pure forestry and its related industries are integral parts of the timber industry as a whole, and as such cannot be divorced from each other.

With this appreciation, then, of the economic necessity for keeping costs in forest operations as low as possible will be realised the importance of devoting time and effort to the resolution of the problems involved. It is for the forester to decide on the practical measures necessary to implement the achievement of the economist's objectives. It is claimed by its protagonists that in no other way can this be more adequately and effectively accomplished than by the employment in the industry of the piece-work system.

Without immediately dwelling on the pros and cons of the system as applied to particular operations, a general observation would indicate widespread benefits accrueable from its employment. Personal incentive towards material gain is the panacea of all sagging production curves. Increased output means at the least a reduced percentage of overheads. In practice it will be found that the cost per unit of production will be considerably reduced. Apart from the economic aspect, benefits of another and an equally important nature can be gained through its employment. Relations between labour and management can, under a well organised scheme, be harmonious and mutually beneficial. The morale of the worker is appreciably raised. The significance of this latter factor is of paramount importance not only to the individual

worker but to the community as a whole. It is a well known and deplorable fact, though happily not universal, to find amongst workers the cynical and indifferent attitude to work which characterises the outlook of too many employees in this present age of pecuniary super-consciousness. Work for work's sake is unfortunately a relic of the past. Without surrendering to this lethargy or pandering to the cynic, efforts must be made to overcome the evil by providing remuneration on the basis of value for work done. This is in fact the essence of the piece-work system.

Before arriving at a satisfactory conclusion as to its efficacy or otherwise, an examination of the practical problems involved in its operation will be necessary. The basic principle of the system is that an individual worker is given a particular price per unit for a particular job. This can be adapted to cover a group of workers suitably graded and working as a team as required by the particular operation. In this way advantage, in the first instance, is derived in that the optimum use is made of the labour force available. "Passengers" are immediately pin-pointed and appropriate action can be taken. The value of the introduction of the personal incentive factor has already been mentioned. The extent to which this can influence practice is best illustrated by the following example of an actual operation carried out both on a normal wage basis and on a piece-work basis. (Figures quoted are those prevailing in the West of Scotland in Spring, 1952.) The working gang comprised eight not very experienced workers in charge of a skilled foreman. The operation in question was the replanting of a cleared woodland area on a rough hill-side. The method of planting was "screefing" and notching, the planting distance was 6' x 6', and 2 + 1 transplants of Jap. larch and Sitka spruce were used.

The following is an analysis of the results obtained :

- (1) *On the fixed wage basis :*

Average daily wage per man.	25/-.
Average number of plants planted per day.	600.
Cost per 100 plants.	4/2d.
- (2) *On a P/W. basis :*

Rate paid per 100 plants.	3/3d.
Average number of plants planted per day.	1,000.
Average daily wage.	32/6d.

Thus in this instance output was increased by 66% and the cost per unit was reduced by approximately 22%. Translated into terms of economics and profit and loss this means firstly, because of increased output, a 60% reduction in the charge for overheads. Secondly, recalling to mind the previous concept of a forestry investment, the saving of 22% in the cost per unit or alternatively £22 in every £100 in this, the very first year of the investment, will at 4% C.I. mean at the end of the rotation an ultimate saving of ten times that amount. This combined with the saving in overheads will appear on the credit side of the balance sheet as a very substantial amount. The economic significance of this

is obvious. The individual worker has increased his earnings by approximately 30%. He has given value for wages received and in doing so his voluntary increased effort has produced its just reward. The practical significance of this is equally obvious.

From the strictly economic and from certain aspects of the practical viewpoints, therefore, the advantages of the piece-work system appear indisputable. The word "appear" is used advisedly as numerous pitfalls exist which in the long run can prove costly. The most obvious are, firstly, the tendency to sacrifice quality for quantity, and secondly, the tendency on the part of some workers to avail of the numerous opportunities for fraudulent practices which can, and do, occur. These are real and formidable objections. Both practices, if indulged in to any extent, can negate all efforts at reducing costs by necessitating costly repetition of inefficient work on the one hand, and resulting in appreciable financial losses in operations on the other. While the objections, however, are undoubtedly valid, the problems arising out of them are not insurmountable. They introduce two very important and inter-related factors which have a considerable bearing on the operation of the piece-work system as a whole.

- (i) The quality of labour employed.
- (ii) The efficiency of the supervisory staff.

With regard to the former the simple fact is that the worker on piece-work must know his job. A capable worker can do his job as efficiently at speed as he can do it in slow time. The man who is capable and efficient will not need to resort to fraud to make his wages. This concept of labour however, human nature being what it is, is idealistic in the extreme and can never be fully achieved in practice. The importance of the second factor is thereby emphasised. In the writer's experience no greater influence is exerted on the success or failure of any piece-work operation than by the efficiency of the supervisor connected with it. He holds the key position in the entire organisation. A good supervisor can quickly discern the efficient from the inefficient. He should, to inspire confidence, be competent to give practical demonstrations where such are required to initiate a willing but unskilled worker. Skippy or careless work must be checked immediately and if necessary stringent measures taken to ensure against a re-occurrence. To combat fraud he must always be on the alert and possess a complete awareness of what he is up against. He must use his ingenuity to improvise different checks and cross-checks on the units of work completed by any individual worker. This supervisory efficiency must be maintained at all levels. An error in the estimation of the rate to be paid on the part of the staff in managerial capacities, can, likewise, lead to losses and result in higher costs of production rather than lower. Thus, whatever the quality of labour employed, were it even the best, inefficiency on the part of squad supervisor or manager can defeat the purpose of the entire system.

Consideration in detail in relation to individual operations will grant a reasonable picture as to how the piece-work system operates in practice. Generally speaking, over the wide range of forest operations every phase of activity can be adapted to allow for working on a piece-work basis, in the nursery and in the forest (planting, pruning, thinning and final fellings) and in the saw-mill. In some of these operations the system will be found to work more easily than in others. The greatest factor to be dealt with is the diversity of conditions which can exist even in any one individual job. Where the work is confined to rather stereotyped conditions no such difficulty arises.

**THE NURSERY:** Nursery operations while not in themselves items which come under individual headings in the compilation of a balance-sheet prepared for the estimating of profitableness of a forestry investment, are nevertheless the basis of evaluation for the figure for cost of plants in such computations. This figure in any year's planting programme can reach appreciable proportions and it is important therefore that every effort should be made to keep it at as low a level as possible. On the general principles already established this can be achieved by the employment of piece-work. As against this, however, it must be remembered that first quality nursery produce must be produced as a fundamental to the ultimate cultural success of the forest. Notwithstanding all that has been written regarding the feasibility of combating the inclination to sacrifice quality for quantity it is felt that on this account no unnecessary risks in relation to quality of produce should be taken in the nursery. In common with all young life, seeds and seedlings are delicate organisms and as such should be handled accordingly. Operations therefore involving preparation of seeds, preparation of ground, preparation, sowing, tending and weeding of seed-beds, and lifting of seedlings should not be unduly rushed and are best carried out on a normal weekly wage basis. Once the seedlings have reached the lining-out stage, however, piece-work can be safely employed. Its employment in this particular operation however presents certain difficulties when the method of lining-out by hand is used. The lining-out squad must consist of men of equal ability and deftness, else the pace is dictated by the slowest man in the squad and the purpose of the system is defeated. This equity of ability is very difficult to attain in practice, particularly where large gangs of men are employed. The problem can be overcome in two ways, either by sectioning off the lines and dividing the squad into teams of 4-6 men, each team working independently. With such small teams a greater degree of equality as between individuals can be attained. This method may not, for obvious reasons, commend itself. An alternative is to use lining-out boards. With these the whole squad can work in unison and the less skilled can be put on such jobs as carrying boards or filling-in trenches. Thus every man can be moulded into a position in which his ability is best exercised, and therefore no worker is a drudge or a brake on his fellow-workers. The essence of any such operation is obviously a spirit of team-work.

**THE FOREST : *Establishment of Plantations :*** In this initial phase of a forestry enterprise no returns are forthcoming to offset the expenditure involved. When returns do appear, on the commencement of thinning operations, it must be remembered that they have a great burden to bear in making up for the costs involved *ab initio*. Bearing in mind also the fundamental concept of the cumulative effect of compound interest on each and every pound spent in establishment and this over a period of from fifty to sixty years, saving of expense in these early stages is all important. Every effort must be made to lighten the burden on the credit side of the balance-sheet so that both sides of the A/c will ultimately balance. Again it is claimed that piece-work efficiently employed will go far in achieving the desired economics.

***Clearing and Burning :*** This operation which is a preliminary to planting on many types of ground can be, as is well known, a very expensive business. When continued over an indefinite period it tends to become a monotonous and time-killing occupation. The greatest advantage in introducing piece-work then is in the provision of the incentive for sustained effort. Its introduction however presents certain difficulties. Scrub is normally so scattered and diverse in nature that a unit of work is difficult to define. Where the scrub is fairly uniformly distributed and of a constant density a rate per square chain, or per acre, between a group of evenly graded workers, can be readily arrived at. This rate will naturally depend on the density and type of scrub involved. Where scrub is scattered and lacks uniformity the method of working depends to a great extent on an experienced supervisor. A good man can by inspection of an area to be cleared arrive at a round figure for which the job can be accomplished, and sets the job on the basis of this particular price for the field, or the clump, or thicket, or whatever such unit of area as may be determined by him.

An alternative method of introducing the incentive factor into this operation, and one which, because of its simplicity, might perhaps have wider appeal, is in the granting of a bonus per acre, again taking into account the density of scrub involved, this bonus to be divided amongst the squad on completion of the allotted task.

In clearing operations, once a piece-work rate or a bonus has been decided upon, strict supervision can be dispensed with as the operation does not require any great degree of skill and any omissions on the part of the workers are immediately self-evident.

***Fencing :*** This operation is normally a "must" in all forest enterprises in this country. The expense involved is almost legendary and is indeed a great deterrent to the replanting by private individuals of the numerous small parcels of felled woodland which are scattered through various parts of the country. More attention should perhaps be paid to the possibility of replanting without rabbit fencing, by a vigorous and sustained drive against vermin of all types, particularly rabbits. The writer has, in the past, been associated with an estate in the West of Scotland, where rabbits are plentiful, but where 400 acres of young

plantations have been successfully established without rabbit netting being used, but where a sustained offensive against vermin was a first priority job.

Where fencing must be tackled, however, it can be organised to a high degree of efficiency and economy on a piece-work basis. For operational purposes it will be necessary to divide the work into two phases.

(1) Transport and spreading of materials.

(2) Erection.

(1) The former is a variable factor depending on the distance and type of terrain to be covered, and also on the type of transport available. This latter item is most important where hill-fences are involved and vast tracts of relatively inaccessible ground have to be covered. The costs of spreading materials on this type of ground can reach a very large proportion of the total cost of fencing. Two alternatives exist for the spreading of materials in these cases.

(a) Horse and sled.

(b) Track-laying or crawler type vehicles.

The former is the slow but sure method. All that need be mentioned in connection with it, from an economic point of view, is that in these days of high wages (for men and horses) time means money, and every pound spent unnecessarily is again increasing the burden on subsequent income.

In the writer's experience, mechanisation is a sure way of saving expense in this phase of fencing operations. With the correct type of crawler vehicle the time factor can be cut to one-sixth of that spent in the former method. This does not necessarily mean a reduction of five-sixths in the cost involved, as admittedly, working costs are higher with machinery. The margin involved, however, is quite adequate to allow amply for this and still result in a saving of as much as forty per cent. The heavier types of crawler tractors are not the best for this type of work. The most suitable machine is a war-developed track-laying vehicle of the amphibian type known as the "Weasel." With this machine phenomenal performances can be achieved. It resembles the Bren-gun-carrier in appearance. When stripped of its non-essential features (armour plating, guns, etc.) it weighs only about 35 cwts. Its ground pressure per square inch is about 2 lbs. It is powered by a 30 H.P. engine and is equipped with two gear ranges (high ratio and low ratio) giving 8 forward speeds and two reverse. It can reach a speed of 15-20 M.P.H. over moorland. With sled trailer attached it has a capacity of from 60 to 80, 5' stobs with 6 to 8 straining posts per load. No ground is too soft for it (it floats). Drains can be crossed without bridging and the edge of the drain will not be broken down. Petrol consumption is high, approximately 20 gallons per 9-hour day. On rocky ground the tracks are liable to breakages. Its initial cost is not high (second-hand ex-army machines were once available at £150-£200. They are now costing £400 to £600. The possession of this



machine does not necessarily eliminate the horse altogether. In some cases a combination of both will be required to cope adequately with all conditions.

In determining a piece-work rate for such an operation experience (as in all operations when variable factors have to be taken into consideration) is the only basis on which the rate can be arrived at. It is normally expressed as a rate per yard of fence to be erected.

(2) This is a phase of the operation where rates may, to a certain extent, be standardised. Variable factors are not so likely to occur. In extreme cases some allowances may have to be made for exceptionally rough ground. In practice, however, the necessity for doing so does not often arise, as on most jobs good working sections will exist which will offset the bad ones. The rate is best made up on the basis of a price per yard per wire, with a separate rate for digging straining post-holes and erecting strainers. Erection of gates and watergates should also be separately rated. Some operators may, however, prefer an all-in inclusive rate per yard, this to include the carrying out of all work involved in the erection of a satisfactory fence for the purpose required. The writer has found, however, that on the latter basis, if too great a proportion of strainers are required or too many gates or water-gates to be hung, and too many depressions and hollows to be overcome, the operator will tend to cut down below the minimum required the number of straining posts, skimp the erection and proper hanging of gates and not take pains with the depressions and hollows: either that or pack up the job and look for more money. On the former basis all items are cut and dried for him and a more satisfactory job is the result. In the case of rabbit-proof fences it has been found that the work can be considerably speeded up, and consequently done at a lower rate, by, instead of trenching the lower outturned portion of the netting along its entire length, merely turning it out on top of the ground and securing it with a flat boulder or sod about every yard or so. The vegetation subsequently growing under and through the netting will quickly get a grip on it and hold it as firmly as if it were trenched all the way. This has been proved to be satisfactory from a protection point of view. It has in fact proved advantageous to the trapper. Rabbits will in a short time discover the weaknesses at points where the wire still lies bare on the ground before the vegetation has gripped it. They will make openings and tend to use these regularly. Traps or snares set at these obvious points will provide a regular daily quota of captures. These weak points may later be made secure.

The following figures may help to illustrate how erection rates are arrived at. (Again rates quoted were those prevailing in the West of Scotland in 1951-52.)

Basic rates :—Plain or barbed wires	... ..	1½d. per yd.
Netting wire (laid as above)	... ..	4d. „ „
Digging straining post holes, and erection of strainers	... ..	3/- — 4/- each



Erection of gates (including gate posts)	...	...	...	25/-	..
Erection of water-gates	...	...	...	10/- — 30/-	..

Thus a fence consisting of, say, 5 plain wires and 1 barb, with stobs at 6' centres would be at the rate of 9d. per yard with 3-4/- for each straining post (depending on the nature of the ground) and 25/- for erecting each gate and 10-30/- for each water-gate depending on its size. For a rabbit-proof fence consisting of two plain wires and 42" netting and stobs again at 6 centres 7d. per yard would be the rate with similar allowances for the other items as above. By extending the stobs to 9' centres which would be ample for a fence of this description a saving of approximately 1d. per yard would be effected.

*Draining:* This is an operation the unit cost of which can be variable in the extreme. Two broad categories are recognised, opening new drains and cleaning or re-opening old drains. A range of prices can, however, be adapted to suit the individual sets of conditions which occur. Peat ground normally provides the optimum conditions for working, the peat being easily cut and easily lifted out. This type merits the lowest rates. At the other end of the scale is a stiff gley in which the soil will stick to the implements like glue or rough stony ground where pick and shovel are constantly required and consequently progress is slowed down considerably. (In the former type the worker should always try to maintain a pool of water at his feet in which to dip his implements periodically. This reduces the tendency for the soil to adhere tenaciously to the spade or shovel or pick.) Another factor which must always be allowed for is the size of drain required. Again two broad categories are recognised here, viz., leaders and laterals. Taking these factors into consideration then, a range of rates might appear somewhat as follows:—

Peat drains — laterals	...	...	3/- to 3/6d.	per chain
" " — leaders	...	...	5/- .. 6/-	" "
Stiff gleys, or stony ground — laterals	...	...	6/- to 6/6d.	" "
" " " " " — leaders	...	...	12/- .. 13/-	" "

Intermediate types such as in normal mineral soils would be at intermediate rates.

It will often be found convenient and economical to combine mounding with draining. This is achieved in the case of planting at 6' x 6' by spacing the laterals at 24' centres and as the drains are cut and cleaned spreading the turfs or mounds two on either side of the drain the first being 3' from the centre of the drain and the second 9'. An equitable rate for this combined operation would be approximately 4/6d. per chain.

In the case of the second broad category of drain types, viz., the old drain, no hard and fast sets of conditions can normally be determined. In old woodland ground especially, these drains can be filled with a variety of obstructions which render normal rate-fixing procedure

invalid. Rate-fixing can be based only on experience, and rates can vary from 5/- to 30/- per chain.

In drainage operations as a whole, however, maximum economy is achieved by the employment as far as possible of drainage machinery. To such machines soil types are on the whole a matter of complete indifference. Certainly the range of its susceptibilities to soil types is considerably reduced in comparison to that of manual labour. Machine drainage rates on the same basis of evaluation as the manually made drains above would be for all types from 2/3d. to 2/9d. per chain. Considering that drainage will in some cases be as intensive as 300 chains per acre, this will involve a considerable saving in expense which would more than justify the substantial investment of capital necessary for their purchase.

*Planting:* This, the preliminary cultural operation in the establishment of plantations, holding as it does such an important position in the annual programme of afforestation in this country, merits a thorough investigation as to the feasibility of operating on a piece-work basis, both from an economic and a practical point of view. An example from actual practice has already been quoted as an illustration of the effect of the system as a whole which indicates the economies that can be effected in planting costs. These being effected in the first year of the rotation have a pronounced influence on the ultimate economic picture. To reduce this statement to figures; say, for purposes of easy evaluation, the cost of planting was £5 per acre. A 22% reduction in unit cost (as per the illustration) reduces the cost per acre by approximately £1. This applied to a planting programme of 100 acres would mean an overall saving in one year of £100. This amount capitalised at 4% for 60 years amounts to approximately £1,000. These figures speak for themselves, hence from the economic point of view the advantages of the piece-work system appear indisputable.

However, the success of the entire forest enterprise depends to a large extent on the efficiency displayed in the practical accomplishment of this phase of the work. From this point of view, however, no inherent disadvantages would accrue from the use of P/W. It is an established fact which has been well proved in practice that transplants can be planted out as well and as efficiently at a steady rapid rate as they can be by taking ample time to it. A deftness and celerity is achieved in a short space of time by a capable practised man and this can be maintained by him for the entire length of a working day almost without variation. Periodic testing by the supervisor on the efficiency of planting by individual men will almost certainly maintain the degree of efficiency at a high rate.

It might be claimed that the system could possibly fall down through fraudulent practices by employees to such an extent that its purpose would be defeated. This would be the case if as much money could be fraudulently converted as to negative the saving involved. In practice this is veritably impossible. Any large-scale fraud such as would be necessary to achieve this would be immediately self-evident. As pay-

ment to employees is made after the completion of work, where any such large-scale fraud is evident, payment can justifiably be withheld and thus no loss is incurred. Petty offences will, however, be attempted, and no doubt successfully at times. An efficient supervisor, however, can combat these practices by various checks and cross-checks. A strict account should be kept of the number of plants issued to each man. Random "line checks" can be carried out, that is counting the number of plants in a line and cross-checking against the number of lines planted and plants issued. Or alternatively "bundle checks," that is unobtrusively observing the point where an individual opens a new bundle and likewise later observing the point where the last plant in the bundle is inserted and counting the intervening plants and cross-checking with the number in the bundle. If any discrepancies are discovered the severest action should be taken with the individual concerned. In this way a supervisor can build up a fear against the consequences of any sharp practices and thus eliminate to a great extent even petty offences. In fairness to workers it should be mentioned that good capable men generally possess an inherent sense of honesty and it will be found they will not resort to such measures to make a wage. They have no need to.

In large scale planting operations on a P/W basis it will be found useful and economic to have boys available for the purpose of distributing plants. Where men are engaged on planting at a rate per 100 it is unfair to expect them to leave off work to collect plants from scattered depots. Also a considerable loss of time and loss of production is involved. The distribution of plants is a job which is well within the compass of any boy and will facilitate considerably the smooth running of the operation as a whole. Employment of boys of school-leaving age should, in fact, at all times be encouraged. In many operations, as well as planting, they can be fitted into the economic picture with advantage. They will become imbued with a sound sense of forest consciousness which they, in their inimitable fashion, will pass on to their compatriots. Likewise when recruited at this stage they are, in embryo, the skilled forestry workers of the future.

*Grass Cleaning:* This, the next operation in the natural development of the forest, is one which is not readily adaptable to the P/W system. The finding of plants in lush vegetation is a task in which, even for the most expert, extra speed is not always possible. Also when due care is not taken numerous decapitations of plants can occur. Grass-cleaning, however, constitutes a field of activity where boys can be employed to an almost unlimited extent and by doing so economies can be effected. The work is not arduous or over-difficult. The writer has on numerous occasions employed schoolboys during summer holidays on this work and the work has been done efficiently. They must, however, be under constant and strict supervision.

*Brashing and Pruning:* This phase of work is one in which economy of expenditure is of the utmost importance. It is an expensive

operation which produces no financial return. Benefits will undoubtedly accrue to the crop in that the resultant brushings provide a very valuable source of humus to the soil and the nutriments thus provided are ultimately absorbed by the crop. Movement through the forest and subsequent thinning operations are facilitated. No return in hard cash is, however, forthcoming and economy is therefore essential. Again operating on a P/W basis or alternatively a bonus system, are the only methods by which the desired speed of work can be attained. Pruning or brushing is a monotonous occupation and no amount of driving and supervision will achieve the same result. Rates for the operation are based on a price per acre (between a group of workers) or per square chain per individual worker. They will vary with the species involved and the planting distances. Larches will be at the foot of the scale with Sitka spruce at the top. Pines and firs will be at intermediate rates.

Other methods combined with P/W can be employed to reduce costs. One of the most practical perhaps, although not attractive from the marker's point of view, is the marking of the first thinning before brushing. In this way the number of trees on which the pruning saw is employed is cut in some instances by as much as 40%. The trees to be taken out in the thinning can be brushed down with an axe. This is a much more rapid operation and will effect a considerable reduction in the cost of the operation as a whole.

*Thinning*: The thinning of plantation is a phase of forest operations which will henceforth form a large proportion of the work to be carried out in our forests. It is the stage in the forest investment where returns begin to appear. Bearing in mind the vast expenditure which has been incurred to bring the plantation to this stage, it is of paramount importance to ensure that these returns be maintained at the maximum possible throughout the successive thinnings. Recalling again the previous concept of the forestry investment, money realised at this stage will accumulate at compound interest to the end of the rotation.

By carrying out the thinning operations on a P/W basis costs of production can be kept at the minimum. This ensures the maximum returns.

For operational purposes the work is divided into three categories :—

- (i) Felling and snedding or trimming.
- (ii) Extraction to ride or roadside.
- (iii) Cross-cutting into required lengths.

Rates are based on a price per pole for categories (i) and (ii) and on a price per 1,000 linear feet or per cu. ft., for category (iii). It is in the striking of an equitable rate per pole for the former that the success of the whole operation depends. This price per pole is based on the average cubic contents of the poles to come out in the thinning. This must be accurately worked out. The following will illustrate why this accuracy is necessary. If the price per pole were based, say, on an average cubic content of 1 cu. ft. per pole for 1,000 poles, and the work was proceeded with on this assumption, and if in the final actual measurement of produce for sale purposes it was discovered that the

1,000 poles amounted only to 750 cu. ft., *i.e.*, the actual average being .75 cu. ft., then 33% more than was necessary has been expended on the operation, and the purpose of the P/W system has been defeated. In early thinnings a large range of sizes of poles will inevitably exist. Rates of growth will have varied considerably, and different species will exist in different parts of the same compartment. For early thinnings therefore the compartment will have to be sub-divided into zones of relatively uniform rates of growth and an individual average arrived at for each zone. This may also have to be resorted to in later thinnings but to a lesser extent, as the crop tends to become more uniform in the later stages.

Rates for felling and trimming are fairly uniform throughout. In first thinnings an increase in the normal rate per cubic foot is generally necessary to compensate for the very small size of pole involved. The work involved does not vary in proportion to the size of the pole. This will, however, be compensated for by a similar reduction being possible when the final thinning stage is reached, and large poles are involved.

Extraction rates will naturally depend on the distance to be covered. Basic prices per cubic foot are normally fixed on a distance unit of 100 yards. This rate is increased proportionately for every subsequent 100 yards. Rides and roads should be so spaced that no "drag" in excess of 300 yards should be necessary before the poles can be put on a timber wagon or two-wheeled "monkey." When rides are laid out, the fact that they will inevitably be used for extraction should always be borne in mind. On rough hillsides where rides are generally unsuitable for wheeled transport, and roads are few and far between or non-existent, the only economical method of extraction is by overhead wire systems. Patent elaborate equipment for this type of work is available from various manufacturers. Where the volume of timber to be extracted is adequate and continuous, the initial expenditure involved is more than covered by the economies effected in extraction costs as a result of the employment of such equipment. In small areas, however, no such elaborate means are necessary. Satisfactory and economic results can be obtained with a single span of No. 4 plain wire with perhaps 1 doz. or even  $\frac{1}{2}$  doz. suitable pulleys. Where more than one span is required simple intermediate supports can be devised which any blacksmith can manufacture. Intricate braking systems, as occur on the patented devices, can be replaced by the simple expedient of erecting at the base of the run a buffer composed of an accumulation of branch-wood and trimmings. It is of interest to note that hill farmers in Norway use these simple methods of overhead transportation almost exclusively for the extraction of farm produce and firewood from their holdings on the steep hillsides.

Cross-cutting into required lengths can, for the larger sizes of poles, be combined with the felling and trimming operation. This will involve an increased price per pole for this phase of the operation. Where small poles are concerned, however, handling costs in extraction are maintained at the minimum by handling the pole in its full length. If

cross-cutting into numerous small lengths is required, *e.g.*, for pitwood, fencing materials, etc., this operation is best carried out at a central roadside depot by a portable mechanical saw. This is done at a rate per 1,000 linear feet. By increasing this rate accordingly, loading on to lorries can be combined with it.

Hence at every phase of the thinning operation, provided the estimation of the rate has been accurate, the supervisor can at any time, by an examination of the returns know how the operation is progressing financially. This is important, in that if costs are too high in any phase of the operation an analysis of the figures will indicate where this occurs and steps can be taken to remedy the position. For subsequent operations he will be able to estimate accurately in advance the cost of such operations. He is, in fact, in complete intimate touch with the operation from an economic as well as a practical point of view. This constitutes a natural encouragement to the supervisor to maintain a constant interest in the operation.

*Clear Felling:* This operation brings to a close the forest investment. Clear-felling costs being incurred in the final year of the rotation will not, even if excessive, have the same deleterious effect on the investment as a whole as those incurred in the earlier stages. Nevertheless a slackening off in effort is not justified even in the home stretch. Many a race has been lost because of this. Again P/W can bring about the desired economy of expenditure. It is important to remember that the ground must again be used for the succeeding timber crop. No adverse legacies therefore should be allowed to follow on from one rotation to the other. Numerous clear-felled areas have been left in such a condition that large-scale clearing and protection schemes have to be embarked upon before re-planting can be carried out. This can be avoided by including in the P/W rate all the necessary work involved in leaving the site clear and ready for replanting. The rate is based on an inclusive price per cubic foot for timber felled. This, then, allows the next rotation to commence to a great extent with a clean sheet as far as preparatory work is concerned. This gives the succeeding investment a decided advantage when the balance-sheet for that period is being formulated.

*Conclusion:* The importance of maintaining costs at the lowest possible level in all operations throughout the rotation has been indicated, to some extent at least. How this is effected is entirely immaterial in the long run. It is suggested, however, that the piece-work system is a possible and very practical means to this end. This system is employed extensively in forestry in other countries. In Britain, where conditions and problems are somewhat similar to our own, the system is widely used by the Forestry Commission, particularly in planting and thinning and in some phases of nursery work. In private forestry circles in that country no other method of working is visualised where the system can be applied. It is of significance, too, that the F.A.O. Report on Forestry in Ireland recommended its introduction to some extent into operations here. It is offered therefore as a means to an end—economic forestry.