FERTILISERS IN FORESTRY – THE FUTURE*

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Present results with fertilisers in Forestry Commission forests are used, with several qualifications, as a basis for estimating the approximate fertiliser requirements by the Commission up to the year 2010.

Introduction

It is important to outline some major differences between agricultural and forest crops which affect the way fertilisers are used. Tree crops are usually on the ground for 50 to 100 years; in this country most are felled between 50 and 70 years after planting. The age at which a crop of any tree species is finally cut will depend on its rate of growth; the faster it grows, the earlier it will be harvested, and the difference between the best and worst crops growing in a given region will range from 5 to 15 years, depending on species.

There is a very long period before there are any returns on the money invested in a crop. When thinning is practised, the first cuts are made at the 12-year stage but cuts are commonly made at 20 years, and occur at up to 30 years with the slowest growing crops. It follows that the interest on the money invested becomes important for many forest operations, e.g. cultivation, draining, fertilising, weeding. This means that the time money is invested is critical, and no operation is done before it has to be. This affects fertilisation practice in the following way: if a treatment produces a constant effect, in terms of increased yield, regardless of the age at which it is applied, then if the extra yield (or a proportion of it) has to be left until the crop is finally cleared the later the treatment is applied the more profitable it will be. There will always be financial pressure to harvest increased yields as soon as possible: the shorter the time that money is tied up the less is the accumulated cost that counts against the increased output. There is one further marked difference which follows from the longevity of trees. An agriculturist might reasonably estimate the sort of fertiliser regimes which would be used for potatoes, sugar-beet, and wheat in 1980s but would be uncommitted as to the likely acreages of these crops. In forestry on the other hand, the acreages in 1980 of spruce, Scots pine, and Douglas fir planted between 1950 and 1960 can be estimated quite accurately, although because of current uncertainty about the fertiliser responses in a wide variety of species and site combinations only approximate forecasts can be made about the sort of fertiliser regimes likely to be used on these crops at that date.

Nurseries

The total area of forest nurseries in the immediate future is likely to be 1,300 to 1,600 acres (800–1,000 acres in the Forestry Commission, and 500–600 in private hands), the total annual use of fertilisers in them is unlikely to exceed 250 tons of a 21 % N fertiliser, and about the same weight of a 0–20–20 PK compound. Even if curious and unorthodox forms of fertilisers are found to be effective and profitable, the amounts required are unlikely to result in manufacturers making special provision for the needs of forest nurseries.

Forests

In the forest, however, the areas are much greater. The 1943 Forest Policy Report,[1] recommended that the country should have 5 million acres of productive forest. Though the long-term strategic objectives considered at that time have become irrelevant, and economic considerations have largely taken their place, the areas already planted plus the plans announced suggest that by the end of the century there may well be about 5 million acres of forest.

Establishment of plantations

Up to the present time, the only nutrient used in any quantity has been phosphorus, usually in the form of Gafsa or other ground rock phosphates. This is now normally applied once only shortly after planting, and seldom again on all acid peat soils, and most podsolic soils (including almost all sites characterised by ericaceous plants), and on peaty gleys and gleys. There are, however, still large areas of forest on these soil types which were not treated at planting, and which urgently need phosphate. This problem should have been dealt with in the next ten to fifteen years.

The use of potash fertilisers at planting, or within a few years afterwards, is restricted to raised and blanket peats, though there are indications that crops on shallow soils over chalky tills may also respond to potash.

Nitrogenous fertilisers are not used at all at planting. This may seem surprising when one considers the enormous responses of agricultural crops, and also the very marked responses in the nurseries of trees, both as seedlings and transplants. There seem to be several reasons for this. Until the advent of effective contact herbicides and selective herbicides the existing plants, especially on grassy sites, overwhelmed the trees and greatly increased weeding costs, so that there is little incentive to boost nutrient supplies in this stage of a crop's life. Also, many conifers suffer from planting check, and seem unable to use added nitrogen, at least in the first two years following planting. If nitrogen is to be used to speed up establishment then the production of plants by different means, with root systems able to exploit the soil more rapidly, may first be necessary.

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The rate of phosphorus used at planting is about 20 to 30 lb P/acre, and only on the most phosphate-responsive (or phosphate-fixing) soils has thus been appreciably increased. This rate is likely to be used for much future planting, and the total amount in Forestry Commission forests will probably be 3,000 to 5,000 tons of rock phosphate or its equivalent a year.

It is difficult to forecast with any certainty the use of potash on young crops but it is bound to increase with more and more planting on peatland.

Older crops

It may seem strange that work on the use of fertilisers to improve the yield of established crops which are in the thinning stage has only been going on for a few years. This is due partly to the original idea of establishing forests as a primary need, and partly because the problems of establishment seemed so large that all energy was expended on them.

As in agriculture, a wide range of yields are found for a given crop with a mean which falls far below the highest recorded yields. Table I, for example, shows the distribution of Yield Classes in Commission plantations of the highest-yielding of the commonly planted conifers, namely Sitka spruce, which accounts for over 40% of current Forestry Commission planting. The Yield Class is defined[2] as the maximum mean annual volume increment; i.e. the maximum value of the quotient $\frac{\text{total volume production}}{\text{age}}$. The classes represent intervals of 20 hoppus feet* in volume to 3 inches top diameter of log.

*1 hoppus foot = 1·273 cubic feet.

TABLE I

Sitka spruce in Forestry Commission plantations, as at September, 1967

Yield class	Area, thousand acres	% of total area
< 60 (in check)	24	4
60–100	59	11
120–160	400	74
180–220	58	10·5
240–280	2·5	0·5
Total area	543·5	

The small proportion of the three highest Yield Classes, 0·5%, is striking: however the greatest contrast with present day agricultural practice is brought out when it is realised that all the highest yields have been achieved without any additional fertilisers. It is known that many crops in the lowest Yield Classes, 60 to 100, are associated with soils of low fertility: but it is not known how many of the crops in the range 120 to 160—which comprise three-quarters of the Forestry Commission's area of Sitka spruce—would respond to fertilisers (few have had any so far) or whether the crops in the top Yield Classes are limited by factors which can be remedied. (Even if the situation of the crops in the top Yield Classes could be improved, it may not of course be economic to boost the Yield Class to 300 or over.)

Scottish experiments suggest that Scots and Corsican pines in the pole-stage (i.e. 30 to 50 feet tall) are likely to respond to nitrogen applications, but it is not yet known if these responses will be large enough to justify such treatment.

In Welsh experiments on Sitka spruce, phosphorus is the only major nutrient found to improve the growth of pole-stage stands of moderate Yield Classes (130 to 180): there have been no responses to N, K, Ca, or Mg in seven factorial trails. Analysis of the foliage has shown that the trees are reasonably supplied with N and K ($N \geqslant 1{\cdot}7\%$ for 5 trials, 1·5% for two ill-drained sites; K from 0·85 to 1·01%). As in Scotland, Corsican pine seems responsive to N, and Scots pine in England shows responses both to N and P. More detailed results for these trials are given by Binns & Grayson.[3]

There have been few experiments on older crops but there are some suggestions that nitrogen may become increasingly important with age.

Potential use of fertilisers

These results are too few for generalisations to be possible, but it seems that there may be large areas of forest where N and P fertilisation will be effective.

If it is assumed that crops will not be fertilised (other than at establishment) before the first thinning, which is likely to be at 20–25 years, and that the mean rotation is 60 years, the areas of crops coming up for first thinning and entering the last ten years of the rotation, each year, for ten year periods can be tabulated (Table II).

Phosphorus is a slow-acting fertiliser, and the effects of a single application last many years. It is assumed therefore that, following establishment, only one application will be made, probably at the time of the first thinning. In contrast,

TABLE II

Acreages (in thousands) per year of Forestry Commission crops coming into the thinning stage, and into the final crop phase

	1971–80		1981–90		1991–2000		2001–10	
	Thinning stage	Final crop	Thinning stage	Final crop	Thinning stage	Final crop	Thinning stage	Final crop
Spruces	24	3	27	10	33*	13	35*	24
Pines	18	5	20	5	15*	5	15*	18
Larches and Douglas fir	10	2	5	3	5*	3	5*	10
Total	52	10	52	18	53	21	55	52

Assuming: Rotation 60 years; first thinning 20 years; final crop phase from ten years before final felling
* estimated from present planting trends

TABLE III

Potential annual use of N and P fertilisers in Forestry Commission forests, in terms of urea and rock phosphate, tons

	N as urea				P as rock phosphate			
	1971–80	1981–90	1991–2000	2001–10	1971–80	1981–90	1991–2000	2001–10
At planting	—	—	—	—	5000	5000	5000	5000
Thinning stage, spruces	—	—	—	—	1800	2000	2400	2500
Thinning stage, pines	1200	2500	3400	3200	1300	1400	1200	1200
Final crops	400	750	900	2100	—	—	—	—
Total	1600	3250	4300	5300	8100	8400	8600	8700

nitrogen effects last only a few years, and applications at intervals of about seven years, i.e. about five applications in all, are likely for responsive crops.

It is assumed for the purpose of these predictions that half of all pines and spruces will respond to P and that half the pines will respond to N from the thinning stage onwards. It is also assumed that half of the spruce crops will respond to N in the final ten years, i.e. they will be treated once only at the same time as the fifth application on the pines. Practically nothing is known about the responses of larch and Douglas fir, so they have been left out of the calculations.

The rates assumed are 44 lb P and 100 lb N per acre, corresponding to 3 cwt rock phosphate and 2 cwt urea per acre. Using the acreages in Table II and the assumptions set out above, the maximum potential use of N and P fertilisers in Forestry Commission forests is set out in Table III, up to the year 2010.

There are of course a number of uncertainties about the figures. The planting pattern of the 1980s can only be guessed at; it is likely that N will not be used much on lodgepole pine, but will be used on pole-stage Norway spruce; changes in timber prices, fertilisation costs and rates of return required on capital may radically alter the profitability of fertilising by one method or the other. Many plantations may be felled early, for a variety of reasons. Nothing has been said about potassium, which will be needed on nearly all peat soils at some stage or other, nor have private forests been mentioned, which include nearly 650,000 acres of conifers.

One of the great attractions of fertilisation (at the pole-stage or later) lies in the fact that (once responsive crops are identified) its profitability is less in doubt than that of planting. If more jobs are to be provided in the countryside and in wood-using industries and if at the same time Britain's dependence on imported wood products is to be reduced, then it is likely to be more profitable to boost timber production by fertilisation than by planting the poorest sites.

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