USE OF FERTILISERS IN NEW ZEALAND FORESTRY OPERATIONS 1980

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ABSTRACT

In 1980 fertilisers were applied to more than 30 000 ha of exotic forest plantations. This area, about double that treated in 1975, was made up of 7600 ha of new plantings, 19 000 ha of established forest, 3900 ha of marram-grass (**Ammophila arenaria** (L.) Link) sand stablisation, and less than 1000 ha of nurseries, seed orchards, amenity areas, etc. During the year 14.5% of all new plantings received fertiliser, and 2.2% of established forests.

Between 1975 and 1980 the use of nitrogen fertilisers trebled to 1900 tonnes N/year, the use of phosphatic fertilisers doubled to 1100 tonnes P/year, but there were no increases in the use of potassium and magnesium and use of boron declined. Small amounts of molybdenum were used for the first time.

The major change in the types of fertilisers used was an increased use of high-analysis nitrogen-phosphorus fertilisers, particularly diammonium phosphate. The year 1980 saw a major advance in the quality of aerial application of fertilisers, large areas being treated by a helicopter fitted with a guidance system.

It seems unlikely that fertiliser use by 1985 will reach the levels predicted previously.

INTRODUCTION

World use of fertilisers in forests was summarised by Baule in 1973; he stated that the total area of forests that had received fertiliser doubled between 1970 and 1973 to reach 4 million ha. He forecast that total areas would reach 7.8–8.0 million ha by 1975 and 15–16 million ha by 1980.

Bengtson's (1979) figures for the United States showed that, up to 1978, increases were in line with those forecast by Baule. In Great Britain increases up to 1974 followed the same trend but since then there has been a reduction rather than an increase in the amount of fertiliser used each year (W. O. Binns pers. comm.).

The use of fertilisers in exotic forest plantations in New Zealand began in the mid 1950s but up to 1970 the amounts used were rather erratic; between 1970 and 1975 there was a very marked and consistent increase. Ballard & Will (1978) documented these changes and also made projections of increased use that could occur by the year 1985. The present report gives figures for fertiliser use in 1980, half way through that 10-year projection period.

AREAS FERTILISED

Figure 1 is based on data given by Ballard & Will (1978) but updated to include data for 1980. It can be seen that between 1975 and 1980 the area of forest fertilised in the year of planting nearly doubled and the area of established production forest receiving fertiliser more than doubled. These are figures for total forestry operations

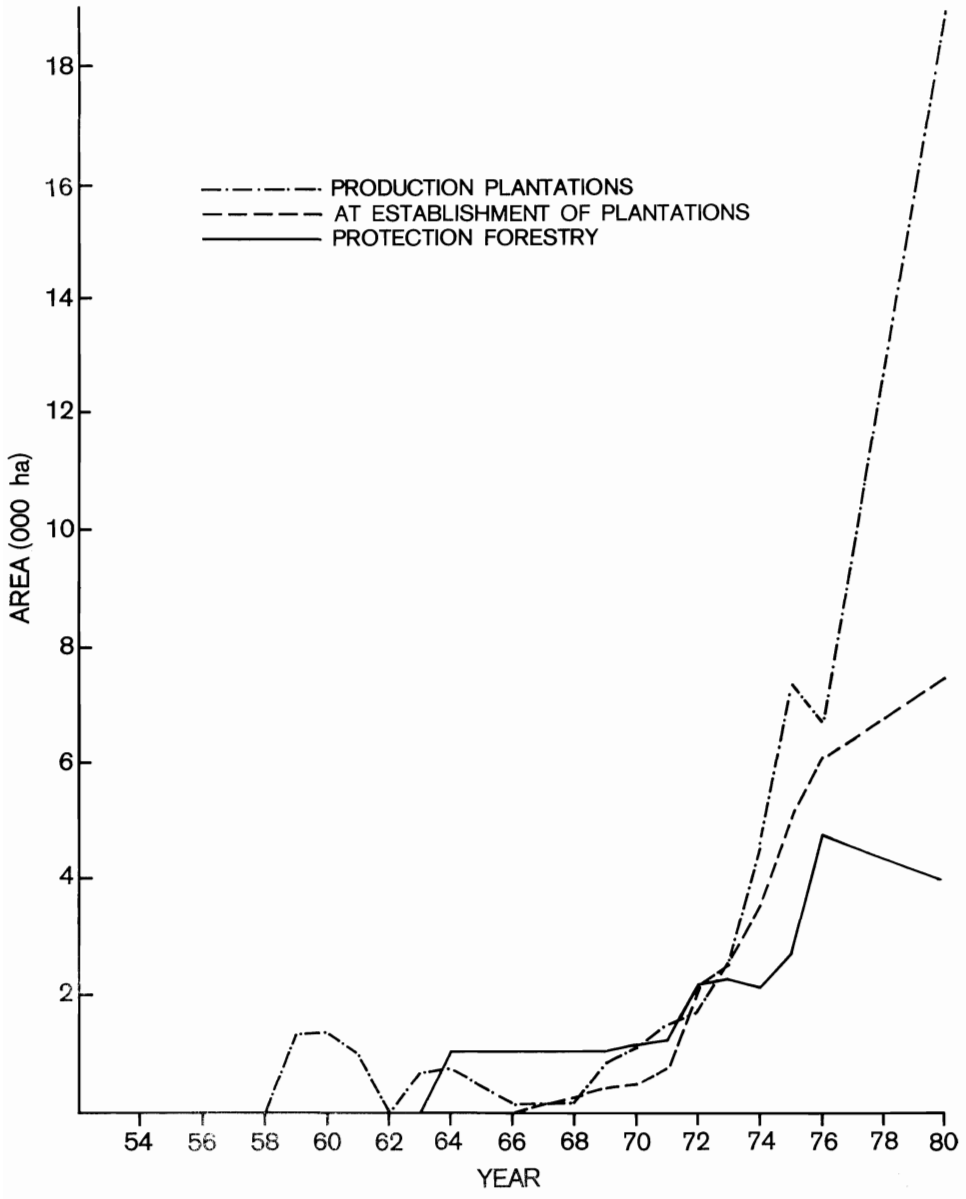

FIG. 1—Forest areas fertilised annually in New Zealand (1954–80)

in New Zealand by both State and private forestry organisations. The 1980 figures are broken into seven regional districts in Table 1; these correspond to the New Zealand Forest Service Conservancies.

The largest increases between 1975 and 1980 in areas fertilised at time of planting have occurred in the Rotorua and Westland regions. In Rotorua fertiliser application to eucalypt plantings accounts for a large part of the increase from 805 ha to 2100 ha/year: in Westland, where it has become the practice to fertilise all pine plantings on pakihi soils and most of those on hill country, the total area treated increased from 16 ha to 1200 ha/year.

TABLE 1—Forest areas (ha) fertilised in 1980 in New Zealand

Region	Exotic Production Forests				Protection forests	Total
	At establishment		Older stands			
North Island						
Auckland	3000	34%*	8 100	6.2%†	3400	14 500
Rotorua	2100	10%	6 400	1.6%	—	8 500
Wellington	220	2%	430	0.4%	290	940
TOTAL	5320	13.3%	14 930	2.4%	3690	23 940
South Island						
Nelson	520	11%	1 450	1.6%	—	1 970
Westland	1200	95%	2 000	11.8%	—	3 200
Canterbury	140	6%	510	1.1%	85	735
Southland	400	9%	75	0.1%	100	575
TOTAL	2260	18.2%	4 035	1.8%	185	6 480
OVERALL TOTAL	7580	14.5%	18 965	2.2%	3875	30 420

* Percentage of 1980 planting
† Percentage of total estalished forest areas

Increased areas fertilised in established production pine forests are largely in the Auckland, Rotorua, and Westland regions. In the Auckland region areas treated with superphosphate have more than trebled. In Rotorua there has been a large increase in the areas of recently thinned stands treated with nitrogen fertiliser. In Westland both nitrogen and phosphorus fertilisers have been applied to the 2000 ha treated.

In the Auckland region the area of marram grass (classified as protection forestry) treated with nitrogen fertiliser more than doubled to reach 3400 ha. However, decreases in high-country revegetation programmes elsewhere in the country resulted in the total protection forestry areas treated increasing by only about 30% above the 1975 level, remaining below the high figure achieved in 1976 (*see* Ballard & Will 1978).

It has been difficult to obtain figures on total areas of forest nurseries but an increase seems likely, probably equivalent to the decrease in areas of seed orchard treated with fertiliser from 170 ha to 40 ha.

QUANTITIES OF FERTILISER USED

Figure 2 updates the data presented by Ballard & Will (1978): between 1975 and 1980 there were large increases in the use of nitrogen and phosphorus. There was steady use of potassium and magnesium and a fall in the quantity of boron applied: regional use of fertilisers in 1980 is given in Table 2. Auckland and Rotorua in the North Island and Nelson and Westland in the South Island are the major regions where fertilisers are applied.

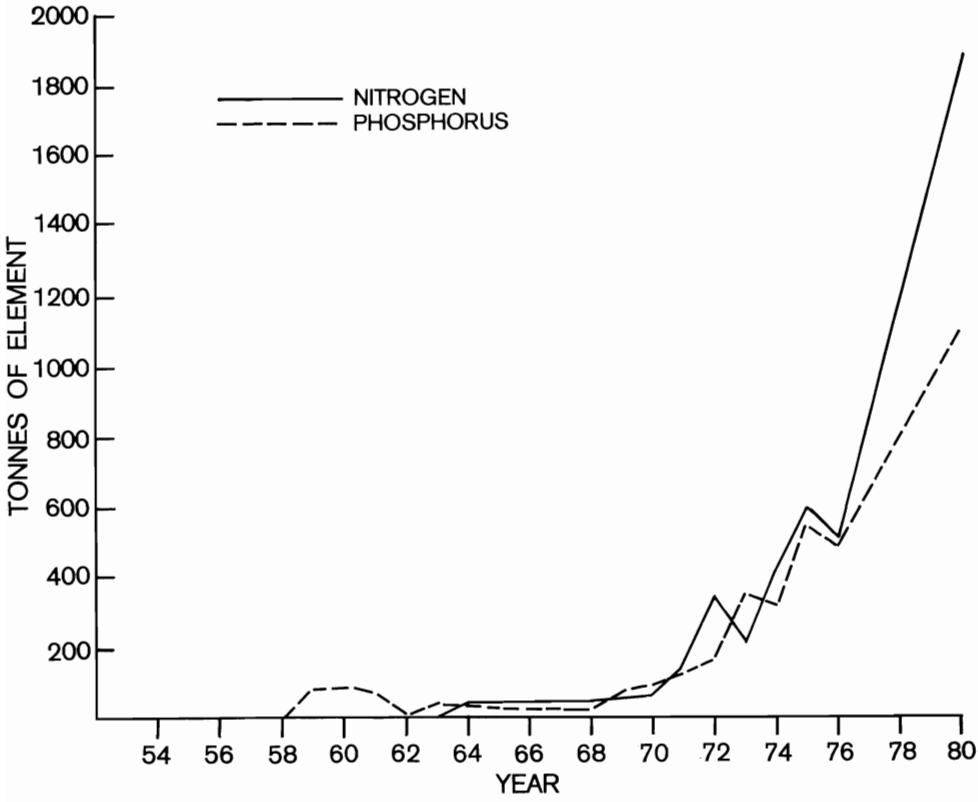

FIG. 2—Quantities of fertiliser elements used annually in New Zealand forestry (1954–80)

Nitrogen: Use of nitrogenous fertilisers more than trebled – an increase of more than 1300 tonnes N/year to bring the total to 1900 tonnes N/year. In the Rotorua region the increase of nearly 1000 tonnes N/year was largely in the fertilisation of recently thinned stands of pine and newly planted eucalypts. In Auckland and Wellington regions increases were associated with sand-dune pine forests: in Westland there were increased applications to both recently planted and established forests on all soil types.

Phosphorus: The increased quantity of phosphorus applied in 1980 – more than double that in 1975 – was used largely in two regions. In Auckland there was an increased application (470 tonnes) to forests on P-deficient clay soils; in Westland, where no fertiliser was used in 1975, use exceeded 200 tonnes in 1980. This use in Westland started on pakihi soils but was adopted for most soils by the end of the period.

TABLE 2—Use of fertilisers (tonnes of elements) in forestry in 1980

Region	N	P	K	Mg	B
North Island					
Auckland	140	800	12.5	4.8	0
Rotorua	1350	50	13.5	7.1	0.4
Wellington	75	5	2.5	0	0
TOTAL	1565	855	28.5	11.9	0.4
South Island					
Nelson	100	55	4.5	0	5.9
Westland	225	210	0	4.8	0
Canterbury	5	5	0.5	0	3.2
Southland	10	15	7.5	1.2	0.4
TOTAL	340	285	12.5	6.0	9.5
OVERALL TOTAL	1905	1140	41.0	17.9	9.9

Potassium and Magnesium: Applications of these nutrients remained at approximately 1975 levels – an increased level of use of magnesium in Westland was counterbalanced by a drop in use in Nelson. Major use of these fertilisers was in nurseries.

Boron: Use of boron fertilisers in 1980 was less than half that in 1975. Use continued to be mainly confined to Nelson and Canterbury and it appears that, after some years of treating a backlog of deficient areas, there is now a smaller area needing treatment each year.

Molybdenum: Following the research of Gadgil *et al.* (1981) it is now management practice to treat all lupin seed sown in Pouto Forest with molybdenum trioxide in the ratio of 1 g MoO_3 to 100 g of lupin seed. In 1980, 53 kg of MoO_3 (35 kg Mo) were used.

Forestry Use v. Total New Zealand Use

Total fertiliser use in New Zealand did not change greatly between 1975 and 1980 so that increased use of nitrogen and phosphorus in forestry did represent an increased proportion of total use. Forestry use relative to total use in 1980 was approximately nitrogen 8% and phosphorus 0.6%.

Fertiliser Sources

A summary of the fertiliser sources used in 1980 is given in Table 3; for comparison, data are given on use in 1975. The most noticeable feature is the increased use of diammonium phosphate (DAP) as a source of nitrogen and phosphorus; other high-analysis nitrogen-phosphorus fertilisers are now also in appreciable use. Sulphate of ammonia is being used on neutral or alkaline soils where volatilisation losses from the use of urea might be significant.

For potassium and magnesium, which are used mainly in nurseries, there has been a marked swing to the use of multi-nutrient high-analysis fertilisers. This has been at the expense of muriate and sulphate of potash (for potassium) and dolomite and serpentine superphosphate (for magnesium). There has also been increased use of potassic superphosphate and Keiserite.

Boron is not included in Table 3 as nearly all boron applied in 1980 was in the form of Dehybor (sodium borate 22% B). This was applied either alone or in mixtures with superphosphate and/or other fertilisers.

TABLE 3—Fertiliser sources used in New Zealand forestry in 1980 (figures are percentages of total element used; 1975 figures are in brackets)

N		P		K		Mg	
Source	%	Source	%	Source	%	Source	%
Urea	71 (82)	Super	67 (88)	NPK(Mg)	63 (46)	NPK(Mg)	47 (12)
DAP	12 (7)	DAP	23 (8)	Pot. Super	27 (6)	Keiserite	25 (2)
NP	6 (—)	NP	5 (—)	Potash	10 (48)	Dolomite	20 (51)
Sul. amm	5 (0.4)	NPK(Mg)	2 (3)			Serp. Super	7 (22)
CAN	4 (6.4)	Other	3 (1)			Serpentine	— (6)
NPK(Mg)	2 (3.8)					Magnesite	— (6)

DAP	Diammonium phosphate
NP	High-analysis NP fertilisers other than DAP
NPK	High-analysis NPK fertilisers
NPK(Mg)	High-analysis NPK fertilisers containing Mg
CAN	Ammonium nitrate plus lime (26% N)
Potash	Muricate or sulphate of potash
Keiserite	Magnesium sulphate (18% Mg)

Methods and Rates of Application

In 1980 two new methods of application were introduced – one for time of planting and one for established forests.

In Westland and some parts of Auckland there has been a move to replace superphosphate with DAP at time of planting. Where a response can be obtained to nitrogen, the higher-phosphorus-analysis DAP means a halving of the weight of fertiliser applied per tree. However, accurate measuring of the amount applied to individual trees has remained a real problem. User-size trials with 50-g compressed "pills" of DAP have been very encouraging – either with or without a sulphur coating the pills stand up to transport, handle well, and ensure that each treated tree receives the same quantity of fertiliser.

The biggest problem in forest fertiliser applications has been unevenness of spread from aircraft. This was highlighted 10 years ago (Ballard & Will 1971) but there have been few if any improvements in the interim. Unevenness of spread across and along flight paths, combined with an uneven spacing of flight paths, have continued to give unsatisfactory spreading patterns. In the Auckland region 1980 saw the large-scale adoption of spreading with a helicopter equipped with a guidance system. This has resulted in a very signficant improvement in the evenness of spread. There are still further improvements that can be made in the use of the guidance system, in the handling of the fertilisers, and in their physical state, but for the first time since

spreading of fertilisers over forests by aircraft began in 1957, substantial improvements have been made and further improvements are in sight. Fuller details will be reported separately.

The most significant change in the rates of application has been in the aerial application of superphosphate in the Auckland region. Originally, on the basis of trials in which fertiliser was broadcast by hand, 5 cwt/acre was adopted as an application rate. When it was realised that unevenness of spread from aircraft was resulting in much of an area receiving considerably less than the nominal rate, the rate was doubled to 10 cwt/acre. This rate converted to 1250 kg/ha and continued to be standard up to 1979. With the promise of more even spread in 1980, application rates were reduced to 1000 kg/ha in the majority of forests and to 800 kg/ha in some others.

1980 USE COMPARED TO PROJECTED USE

Ballard & Will (1978) reported 1975 use of fertilisers and projected the level to which use could rise by 1985 if all potentially responsive forests were fertilised regardless of economics. These figures, together with actual use in 1980, are given in Table 4.

TABLE 4—Use of N, P, and B fertilisers in forestry in 1975 and 1980, and projected use in 1985

	Tonnes of element per year		
	N	P	B
Actual use in 1975	560	515	28
Actual use in 1980	1 900	1140	10
Projected use in 1985 (as forecast in 1977)	14 000	3000	130

The substantial increases in the use of nitrogen and phosphorus fertilisers up to 1980 still leave use well below the projected possible levels for 1985. What are the prospects for further increases in the next 5 years?

Bengtson (1979), in assessing projected demand for fertiliser in forestry in the United States, warned "Forecasting trends in fertiliser consumption in forestry is a much more uncertain business than it was, or seemed to be, 5 years ago. Another oil embargo or radical changes in Government energy allocation or fertiliser pricing policy would nullify the most careful predictions". Bengtson forecast some increased use of fertilisers in forestry in the United States during the 1980s but not more than double the 1978–79 figure. In Great Britain the use of fertilisers reached a peak in 1973–74 when 51 000 ha were treated: since 1976–77 the annual area has stabilised at about 30 000 ha (Mayhead 1976; W. O. Binns pers. comm.).

Here in New Zealand there has been a continuing planting programme on phosphorus-deficient soils. Increased use of phosphate fertilisers can be expected but sharp rises in the cost of superphosphate and improved efficiency in aerial spreading are likely to restrict increases in the quantity of fertilsers used. An increase to the projected 3000 tonnes P/year by 1985 now seems improbable.

Increases in the use of nitrogen fertilisers are more difficult to predict. Locally produced urea will be available by 1983 in quantities in excess of present New Zealand total use and the price is expected to diminish in real terms (PCNZ 1980). New Zealand faces a wood shortage in the late 1980s; recognising the potential for boosting growth in many parts of the country, Bunn (1980) has recommended that nitrogen fertiliser be used to achieve larger final-crop trees.

Although fertiliser will be readily available and the potential for increasing growth has been recognised, it will require major policy reviews if the further sevenfold increase to reach the 1985 projection is to be achieved.

The projected use of 131 tonnes B/year now seems unrealistic. Use of boron dropped from 28 tonnes/year in 1975 to 10 tonnes/year in 1980. Future use seems likely to stabilise between these two quantities.

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