Fertiliser use

New Zealand planted forests environmental facts.

Fertiliser has been used in New Zealand planted forests since the mid-1950s.

Fertiliser use in forestry is very low. In some areas, forests receive no fertiliser. Where it is used, fertiliser is generally only applied a few times during a 25 to 30 year rotation.

Fertiliser use may increase in the future to boost productivity and/or maintain soil nutrient sustainability over successive rotations. The decision to add fertiliser will depend on factors including harvest methods and site fertility.

Good management decreases the likelihood of leaching and losses through volatile nitrogen-containing gases while ensuring the added nutrients are available to growing forests.

Fertiliser use in New Zealand

Fertilisers are used across New Zealand under many land management systems. They may be used to correct nutrient deficiencies, to maintain soil fertility and/or to boost productivity.

Fertiliser use in New Zealand forestry is very low. In many areas, forests receive no fertiliser. The average application rate of all fertiliser used across all planted forests in 2017 (including those with no applications) was 8 kg ha^{-1}, although actual application rates would be higher (common rates are 200 kg nitrogen (N) ha^{-1} and 75 kg phosphorus (P) ha^{-1}). In contrast, an average of 580 kg ha^{-1} was applied to dairy pastures in 2017, and 700 kg ha^{-1} was applied to land growing grain and vegetables.

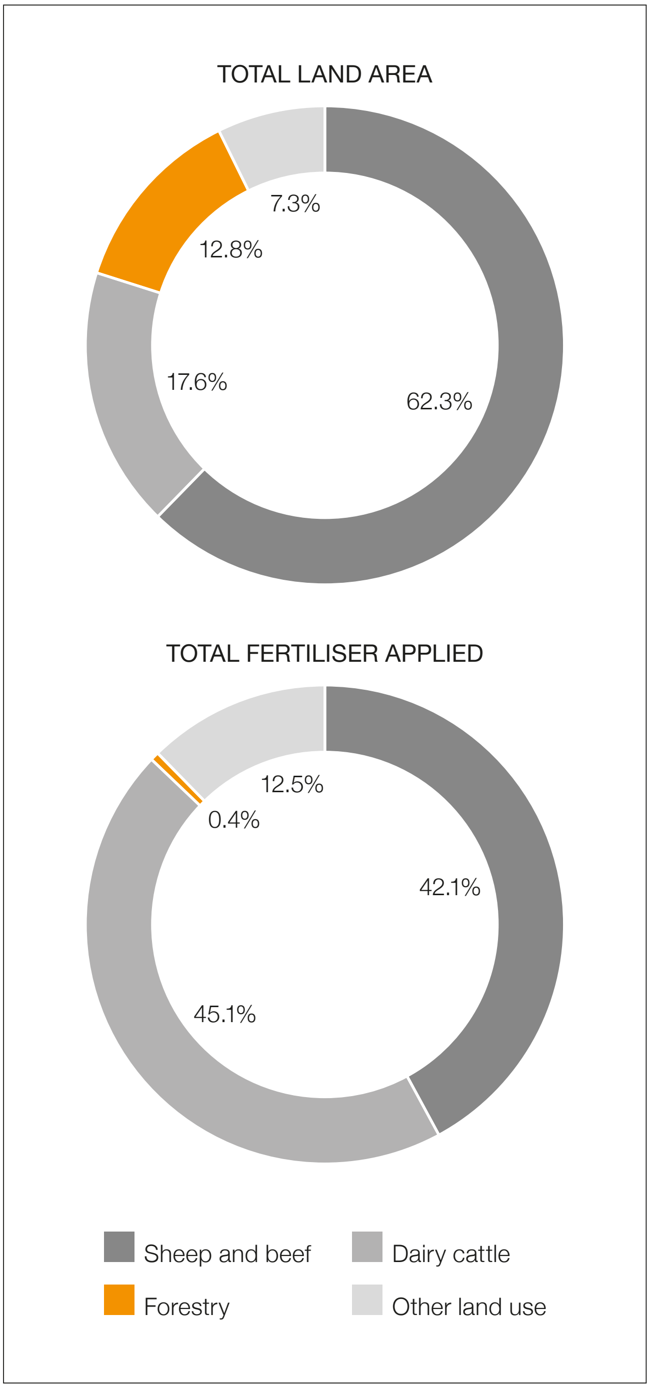

Figure 1: *Land area and fertiliser applied by land area for the major land uses in New Zealand in 2017 (Agricultural Production Census of 2017; https://www.stats.govt.nz).*

Fertiliser has been used in New Zealand planted forests since the mid-1950s. However, the total fertiliser used has not increased substantially over time, while planted forest area has almost tripled since 1975.

Figure 2 shows snapshots of several years, with an indicative application rate comparing the entire forest estate with the total amount of *Pinus radiata* fertiliser additions in that year.

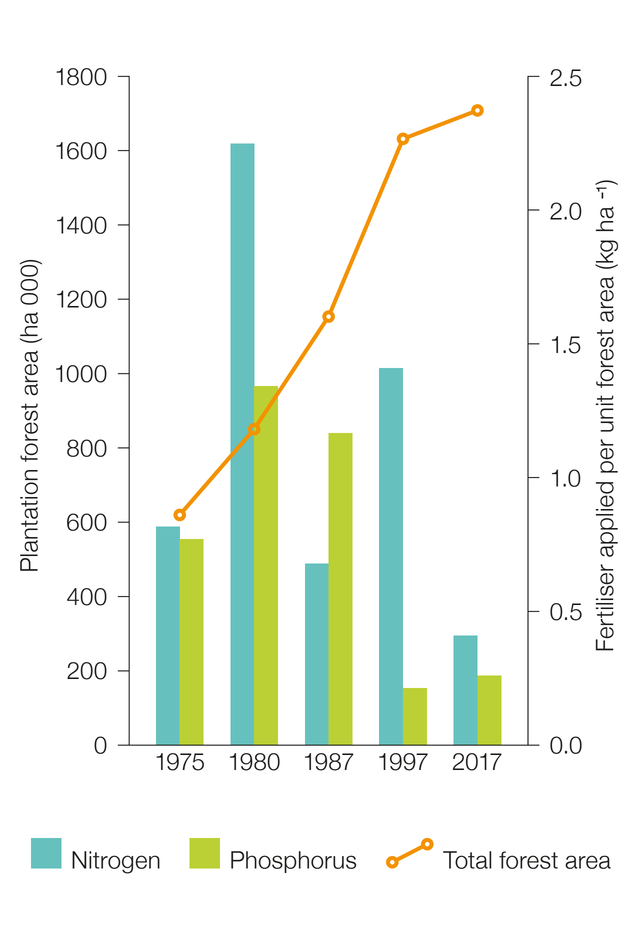

Figure 2: *Total New Zealand planted forest area compared to the amount of nitrogen and phosphorus added to* Pinus radiata *planted forests.*

The major difference between forestry and most other land uses is the frequency of fertiliser addition. Fertiliser is generally applied only once, and at most, a few times over a rotation (25-30 years).

Why add fertiliser to planted forests?

Fertiliser in New Zealand forestry is predominantly applied to manage nutrient deficiencies, generally in conjunction with foliar and/or soil analysis. Although typically less common, fertiliser can also be used to help to increase the productivity of planted forests.

Some areas of New Zealand planted forests are currently entering their third and even fourth rotation. As the number of rotations increases in the future, fertiliser may be used more to replace nutrients removed through harvest and to maintain soil nutrient sustainability. The nutrient removal that may occur through stem-only harvest (including bark) is shown in Table 1.

Table 1: *Nutrient removal through stem-only harvest (including bark) from a range of New Zealand forests (Payn & Clinton (2005)).*

Nutrient	Amount removed through harvest (kg ha^{-1})
Nitrogen (N)	128-337
Phosphorus (P)	22-69
Potassium (K)	168-439
Calcium (Ca)	30-363
Magnesium (Mg)	59-494

The impact of nutrient removal will depend both on the harvest method applied (i.e. de-barking on site would reduce the values shown in Table 1) and the fertility of the site. Nutrient export is only likely to become critical for sites where soils are inherently low in nutrients (Figure 3) and/or in areas where harvesting has significantly disturbed/removed the forest floor organic layer, which can otherwise be a source of nutrients for successive rotations.

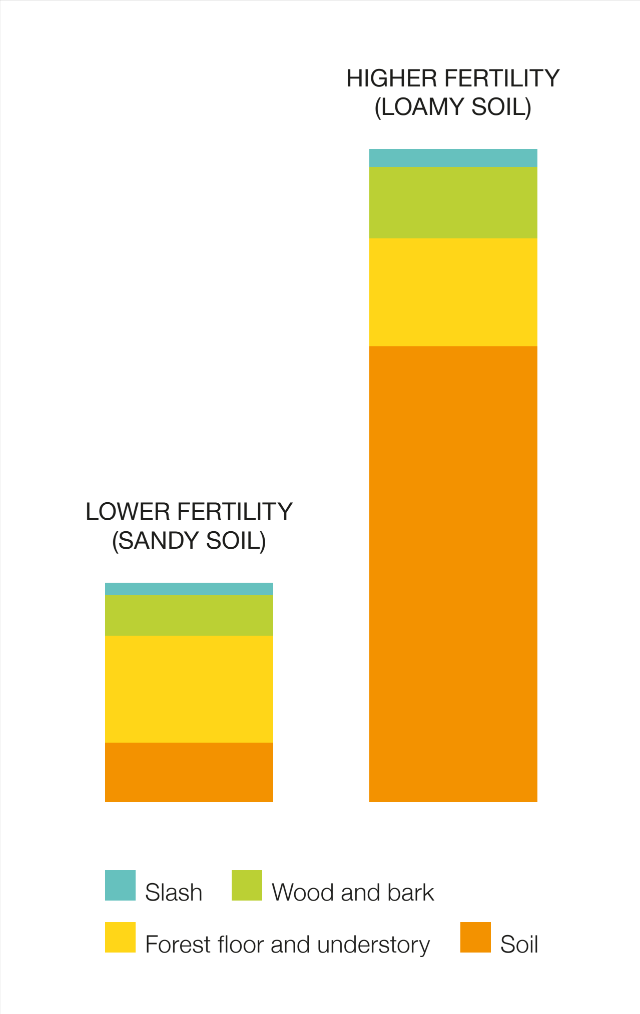

Figure 3: *The relative amount of nitrogen present in different forest components, from* P. radiata *stands on lower-fertility sandy soils and higher-fertility loamy soils. Note: (1) soil stocks shown are only for the top 20 cm of soil; (2) only a small fraction of the nutrient pools shown would be plant-available (Garrett et al. 2015).*

Possible environmental impacts

In general, forests have efficient nutrient cycles with low levels of nutrient loss. However, fertiliser addition to any environment – including forests – comes with a risk of nutrient loss to the environment. The most common pathways are leaching and gaseous losses.

Nutrient leaching. Leaching not only means a loss of nutrients for plant uptake, but may lead to increasing levels of nutrients in streams and lakes, which can affect both aquatic life and drinking water quality. Only a few leaching studies have been done in New Zealand planted forests as they are not expected to have high leaching rates.

Nutrient losses via leaching will vary from year to year, as they depend on climate (leaching cannot occur without drainage) and site factors. When high rainfall causes drainage, the sites most at risk for nutrient leaching are those with very high/repeated doses of fertiliser and those with coarse-textured soils.

Nitrogen leaching. Both indigenous forests and planted forests without fertiliser addition would be expected to have similarly low leaching rates (0.25 - 2.5 kg ha^{-1} yr^{-1}, and up to 5 kg ha^{-1} yr^{-1} in areas with volcanic soils). There is a risk of leaching when forest nutrient capital exceeds demand. This is most likely to occur on highly-fertile sites, during the years immediately following harvest and near the end of rotation.

Leaching in areas with nitrogen fertiliser addition greater than 50 kg N ha^{-1} yr^{-1} can result in soil acidification, which may lead to a decrease in soil cation exchange capacity and loss of calcium and magnesium (base cations).

Gaseous losses. Gaseous losses as a result of fertiliser application are predominantly nitrogen-related. These may occur immediately following urea application (i.e. volatilisation) or throughout the life of a stand when soil conditions are suitable. Volatilisation can result in a significant loss of added N (up to 40%) in the form of ammonia gas. Other losses may be in the form of nitric oxide (NO) or nitrous oxide (N_2O) which is a significant greenhouse gas. Fertiliser addition to planted pine forests is likely to increase these for a short time, but gaseous losses would be expected to only represent a small percentage of added N (i.e. less than 1%).

Best practice

Good management can minimise the environmental impacts associated with nutrient addition. Using precision hand application (i.e. at establishment), avoiding fertiliser addition during periods of high precipitation and correct timing of urea addition and/or using slow-release fertiliser can all decrease the likelihood of leaching and volatilisation losses ensuring the added nutrients are available to growing forests.

Key links

Planted forest soils www.scionresearch.com/?9=61473

Key references

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