

Growing Poplar and Willow Trees on Farms



Compiled and Prepared by the
National Poplar and Willow Users Group



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Guidelines for Establishing and Managing Poplar and Willow Trees on Farms

Compiled and Prepared by the National Poplar and Willow Users Group
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Introduction

Millions of poplars and willows have been planted on farms in recent decades, usually supplied through regional councils for stabilising erosion-prone hill country, providing shelter and shade for farm livestock, vista, resolving drainage problems and, in some regions, as a source of supplementary fodder during dry summer months. However, land management officers are now finding that untended trees on farms can become large and a liability, so they are encouraging farmers to manage tree size by regular pruning.

The participants in this Sustainable Farming Fund project have developed these guidelines to help landowners grow and manage poplar and willow trees on their land for various purposes as part and parcel of farm management.

Poplar and willow trees add considerable beauty to farm landscapes and can encourage bird life. Other contributions could also include timber, farm nutrient management, absorbing greenhouse gases, especially methane, and for carbon credits.

To manage poplar and willow tree size effectively, a landowner should use the appropriate equipment and be adequately trained in tree pruning and felling operations, or should employ contractors to maintain individual trees and shelterbelts. An attempt is made in this booklet to develop ‘best practice protocols’ for establishing and managing willow and poplar trees and using them wisely once they are growing well.

Much of the following information has been supplied by farmers and other landowners, and regional council land management officers, and is based on practical experiences learned through trial and error. The efforts and contributions of all participants are much appreciated. We hope that these guidelines will help farmers and other land managers seeking information to improve their properties in a natural and sustainable way.

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1 Poplars and Willows in New Zealand

Poplars and willows are now very common on New Zealand farms and along waterways. The early settlers saw them as potentially valuable trees for complementing native vegetation and supplying timber, although most early introductions were unsuitable for timber. Some of the early forms introduced to this country were prone to growing heavy and brittle limbs, resulting in frequent breakage, and these have since developed considerable nuisance value – such as the crack willows now ubiquitous along some South Island rivers and the silver poplar with its vigorous suckering habit.

The more recent selections of poplar and willow have been selected with improved features, including non-brittleness and improved form (e.g. narrow crowning). They establish easily and grow quickly in the relatively mild New Zealand climate, but this also means that they need ongoing management to keep them as a growing asset and to prevent them becoming a liability. In recent years regional council land management officers and innovative farmers have recognised a strong need for ongoing management of poplar and willow trees, especially as they develop into large trees and become increasingly prone to storm damage, threatening buildings, farmer and livestock safety and blocking roads, waterways and access routes.

Poplars were first brought into New Zealand during the 1830s. Early poplar tree introductions include the Lombardy poplar (*Populus nigra* ‘Italica’) and the ‘Frimley’ poplar (*P. deltoides* subsp. *monilifera*), a female clone of the American Eastern Cottonwood, and these were planted extensively as shelter and amenity trees on farms and also in public places in rows to form avenues. Other poplar introductions before 1900 included the silver poplar (*P. alba*), which was planted widely for riverbank protection and controlling erosion in hill country. The Chinese or Yunnan poplar (*P. yunnanensis*)



Poplars near Taihape

was reported growing in Marlborough during 1908 and has since been widely planted throughout the North Island because of its drought hardiness. Its foliage also shows resistance to disease and possum grazing, and in cold areas its lovely autumn colouring adds beauty to the countryside.

Overseas poplar breeders developed new poplar clones by crossing different species, and from the 1920s onwards these inter-specific hybrid clones were brought to New Zealand – clones like ‘Robusta’ (from *P. deltoides* x *P. nigra*). In 1956, after the regional Catchment Boards were established in the late 1940s, a poplar improvement programme began at the National Plant Materials Centre in Palmerston North run by the former Ministry of Works and Development.

Likewise, the early settlers introduced willows to enhance the New Zealand landscape. Some weeping willow (*Salix babylonica*) cuttings, said to be collected near Napoleon’s grave on St Helena (when sailing ships called in there for supplies en route to New Zealand), were planted in 1839 at Akaroa on Banks Peninsula. By 1860 the crack willow (*S. fragilis*), golden willow (*S. vitellina*), common osier (*S. viminalis*) and grey willow (*S. cinerea*) were established in different regions. However, crack willows were reported to be causing stream flooding in Nelson by 1880. Other willows introduced between 1860 and 1900 included the golden weeping willow (*S. x sepulcralis* ‘Chrysocoma’), the Kemp willow (*S. x sepulcralis* ‘Sepulcralis’) and the bitter willow (*S. elaeagnos*). In 1934 the Christchurch Botanic Gardens established a collection of at least 60 willow species obtained from Kew Gardens near London that included the popular *S. matsudana*. Since then over 100 cloned selections of willow were evaluated at the National Plant Materials Centre near Palmerston North.

When HortResearch took over this tree improvement programme, poplar and willow research included developing use as supplementary fodder and for resolving other environmental problems. Nevertheless, using these trees for erosion control and shelter remains their primary use.

1.1 Species attributes

Attributes of poplars and willows

Poplars and willows are closely related and are grouped together in the same plant family, *Salicaceae*. These trees have male and female flowers on different plants, and develop very small flowers clustered together in the

familiar catkins. Poplars are wind pollinated whereas willows are mainly insect pollinated. Seeds of these trees are very small, produced in abundance and very light, so are easily spread by wind. Poplars do not flower until they are six to twelve years old, whereas willows often flower in their second growing season. Furthermore, poplar and willow trees belonging to different species can frequently cross with each other, creating valuable hybrid types, and most are easily propagated by vegetative means. By taking cuttings from a single tree we can produce an infinite number of genetically identical trees – better known as clones.

Natural occurrence

On a global scale poplars and willows are distributed very widely. Poplars occur naturally in most temperate and cold regions in the Northern Hemisphere, as far south as northern African countries and southern China, and one species has been found growing isolated further south in Africa. Poplars are the dominant tree species in large areas of North America and Asia.

Likewise willows are extensively distributed in natural situations ranging from arctic to tropical climates, though mainly in cooler environments. In the tropical zones they are restricted to mountainous sites near the timberline, and in the Arctic they grow nearer to the North Pole than any other genus of woody plants. However, no willows are indigenous to Australia or New Zealand.

Since poplars generally have a high soil moisture requirement, most species grow along the moist, free-draining floodplains of rivers and streams.

Some species colonise lowland riverbanks whereas others prefer mountain valleys, or moist hill and mountain country. Some species are adapted to saline



Poplars for soil conservation

soils and desert areas whereas others (especially *P. heterophylla*) grow in frequently flooded swamp areas. The balsam poplars and aspens also tend to tolerate acid soils whereas white and black poplars (such as *P. alba* and *P. nigra*) seem to be more tolerant of saline soils. Conversely, willows are largely forest margin or shrubland species, rather than forest trees. The tree willows are often found on dampish river plains or along waterways and the shrub willows usually prefer growing in boggy heath land or damp stony upland areas.

1.2 Poplar clones for New Zealand situations

The main clones/varieties of poplar grown by nurseries and regional councils for farmers and landowners are: ‘Argyle’; ‘Kawa’; ‘Tasman’; ‘Toa’; ‘Veronese’ and ‘Yunnanensis’. HortResearch tree scientists recommended the following clones for particular situations:

- Drought resistance – ‘Veronese’; ‘Tasman’; ‘Argyle’; ‘Dudley’; ‘Fraser’; ‘Selwyn’; ‘Crowsnest’; ‘Yunnanensis’.
- Possum resistance – ‘Eridano’; ‘Kawa’; ‘Toa’; ‘Shinsei’; *P. trichocarpa*; ‘Yeogi’.
- Wet, sheltered valleys and moist areas – ‘Eridano’; ‘Kawa’; ‘Toa’; ‘Otahua’; ‘Weraiti’.
- Windy, exposed slopes (clones that are better able to withstand breakage) – ‘Veronese’; ‘Crowsnest’; ‘Fraser’; ‘Selwyn’; ‘Tasman’.
- Shelter areas or shelterbelts – ‘Crowsnest’ and ‘Veronese’.
- Non-brittle forms in windy climates – ‘Fraser’; ‘Selwyn’; ‘Veronese’.
- Fodder – ‘Flevo’; ‘Tasman’; ‘Veronese’; ‘Argyle’.
- Timber – ‘Kawa’; ‘Veronese’; ‘Yeogi’; ‘Weraiti’; ‘Otahua’.
- Firewood – ‘Kawa’; ‘Yeogi’.

Poplar and willow names

Farmers and others often refer to their trees by the clone names or species name, such as Yunnanensis, Kinuyanagi (actually species called *Populus yunnanensis* and *Salix schwerinii*, respectively), and ‘Kawa’ or ‘Crowsnest’ (clones). In this booklet we will therefore give the ‘common’ name in brackets after the species and later refer to it by this name. Likewise clone names will appear with single quotes (except in headings).

Available poplar clones

Most of the poplars currently available for supply are listed below in alphabetical order. Availability depends on which clones grow well in each particular region:

Argyle (*P. deltoides* × *nigra*)

‘Argyle’ was the first of a series of 1980 hybrids to be released, the main feature being its early, rough bark development. It is a broad, open-crowned tree that can develop heavy branches in the crown, like ‘Flevo’. However it produces a lighter crown when grown on harder and less fertile sites. It is not suitable for windy sites because it is brittle.

Crowsnest (*P. × euramericana* × *nigra*)

‘Crowsnest’ is a smaller growing tree with upright branches that become heavier as it ages. It can be used as a conservation tree, particularly in eastern drier regions. Growth rates are good, given adequate moisture, and it is recommended for horticultural shelter as the stems are lighter than ‘Tasman’ and need little side trimming. ‘Crowsnest’ shows good drought tolerance and wind resistance. It is not recommended for moister climates because of susceptibility to black spot disease. This clone is becoming increasingly popular in Hawke’s Bay.

Chinese poplar (*P. yunnanensis* or ‘Yunnanensis’)

‘Yunnanensis’ is slower growing than its two hybrid siblings ‘Kawa’ and ‘Toa’. It was widely planted in New Zealand in earlier years for soil conservation, but it takes three years to produce poles instead of two. It shows good drought resistance once established, however it is hard to produce straight poles of ‘Yunnanensis’ and roots poorly from a pole, so is best established as a rooted cutting. Its leaves are dark glossy green and it holds its foliage well into winter. It is also very resistant to possum browsing.

Dudley (*P. deltoides* × *nigra*)

‘Dudley’ is a good upright tree with only a few heavy limbs. It is the only male tree of the 1980 series of *P. × euramericana* releases. ‘Dudley’ and ‘Selwyn’ are slightly less resistant to rust than other similar clones, though this is not a problem in more exposed sites. It has a wood density higher than the other *P. deltoides* × *nigra* clones.

Eridano (*P. deltoides* × *maximowiczii*)

‘Eridano’ is fast growing and resistant to rust and leaf spot. It has large glossy leaves and brittle branches that can be damaged by winds but it is unpalatable to possums.

Flevo (*P. deltoides* × *nigra*)

‘Flevo’ was released during 1973-1975 in response to the poplar rust problem. It grows best on moist, fertile soils with free drainage. It should not be planted on sites prone to mid-summer drought. The tree form of ‘Flevo’ is leaning or wavy on windy sites, and broad-crowned. ‘Flevo’ is highly palatable to stock and can be pollarded or pruned to supply additional fodder during droughts. It is described as one of the best types for use as fodder in the southern South Island, though not valuable for other uses there. ‘Flevo’ has shown excellent rust resistance. However ‘Flevo’ should not be used for soil conservation since its form makes it prone to wind breakage and it is extremely difficult to manage except in a pollarded situation. There are much better choices available. It has been replaced in nurseries by newer clones with a more upright and narrower crown.

Fraser (*P. deltoides* × *nigra*)

‘Fraser’ is a very narrow tree with a light open canopy. It is a good conservation tree when minimal shade is required, similar to ‘Veronese’ and ‘Crowsnest’. Experience shows that this clone holds excellent form even in the windier areas, though its lighter stems are also prone to breakage on exposed sites.

Kawa (*P. deltoides* × *yunnanensis*)

‘Kawa’ has a narrow crown and is also possum resistant. ‘Kawa’ is an excellent conservation tree on moist slopes in areas that are not exposed to excessive wind. New greenish-bronze leaves emerge in late September.

‘Kawa’ produces some of the densest poplar timber, developing up to 360 kg per cubic metre and making it the leading timber-producing poplar. It is also a good firewood tree planted in a block at 2 m x 3 m on a valley floor. ‘Kawa’ keeps its foliage in winter longer than the × *euramericana* hybrids.



‘Kawa’ poplar

Margarita (*P. deltooides* × *nigra*)

‘Margarita’ is a clone that grows best in eastern and northern warmer parts of New Zealand. Its narrow crown makes it suitable as an avenue tree. It is rust tolerant.

Otahua (*P. deltooides* × *nigra*)

This clone has an upright crown and a heavier stem than the narrow-stemmed crowns seen in trees like ‘Fraser’. This is a medium crowned clone of more open form. ‘Otahua’ is currently not prone to rust. It has fewer heavy limbs than ‘Argyle’, and a smoother bark as a young tree. It grows well in eastern North Island areas.

Pakaraka (*P. deltooides* × *nigra*)

‘Pakaraka’ has a slightly wider crown than ‘Margarita’ and also grows well in northern and eastern North Island regions. It is also rust tolerant.

Selwyn (*P. deltooides* × *nigra*)

‘Selwyn’ is a narrow, more open-crowned tree, suitable for more sheltered valley sites than ‘Weraiti’ and ‘Otahua’, both of which have been planted in greater numbers so far. ‘Selwyn’ has been planted alongside ‘Fraser’ on more exposed and drier sites where they perform well together.

Shinsei (*P. nigra* × *maximowiczii*)

‘Shinsei’ offers good possum resistance. It is a narrow formed tree that develops its heaviest branches at the whorl and does not grow very heavy limbs. The leaves are dark green and thicker than the × *euramericana* types. While this is a good clone for inland moist sites, new *P. nigra* × *maximowiczii* crosses are becoming available that show improved form and performance.

Tasman (*P. deltooides* × *nigra*)

‘Tasman’ is a narrow tree when young but develops some heavier limbs from the whorl as it ages. It is not as large as ‘Flevo’. ‘Tasman’ shows some rust resistance but is not recommended for shelterbelts in horticultural situations, as it grows too large. It lacks drought tolerance, so should not be planted on dry sites.

Toa (*P. × euramericana* × *yunnanensis*)

While ‘Toa’ is broader and heavier in the trunk than ‘Kawa’, it is still classed as being a medium-to-heavy crowned tree with a narrow growth form. It is also an excellent conservation tree in inland areas with good moisture. ‘Toa’ leaves are shaped like those of other × *euramericana* hybrids (such as

‘Crowsnest’), but are darker green and it bears much more leaf and a denser crown. Its juvenile leaves are larger and prone to wind damage.

Veronese (*P. deltoides* × *nigra*)

‘Veronese’ is a × *euramericana* hybrid black poplar imported from Italy and is a good straight-stemmed and narrow-crowned tree. It has small leaves similar to ‘Tasman’, and good drought and wind tolerance. However, it is prone to rust disease in areas where high humidity and heavy dews occur, especially in western areas when planted in low-lying situations. Rust strains are variable, however, and currently the drier East Coast regions still produce excellent ‘Veronese’ pole material.

Weraiti (*P. deltoides* × *nigra*)

‘Weraiti’ has a good shaped crown with a heavier stem than most recent hybrids. It will produce a few heavier branches but not to the extent that ‘Argyle’ can. It is another hybrid performing well in eastern North Island areas, where it rapidly develops height and trunk diameter, offering good potential for timber production.

Yeogi 1 and Yeogi 2 (*P. alba* × *glandulosa*)

Released in 1977, ‘Yeogi 1’ and ‘Yeogi 2’ are hybrid clones from Korea. They sucker readily. They are slow rooting when grown from cuttings. Both clones are hardy and similar in their site requirements to the silver poplar. They develop better form when grown in a plantation than when exposed. ‘Yeogi’ clones develop heavy limbs, which makes them less suitable in exposed situations. For this reason and the slow rooting behaviour, ‘Yeogi’ is not favoured for soil conservation, but should be considered for plantation timber since both clones are highly resistant to poplar rusts and *Marssonina brunnea* leaf spot disease.

The clones ‘Argyle’, ‘Margarita’, ‘Dudley’ and ‘Pakaraka’ all have very similar characteristics – generally heavy crowns and medium brittleness but they are ‘bulk’ growers and their early bark is rough which is important for protection from stock. The clones ‘Fraser’ and ‘Selwyn’ tend to be very erect, narrow crowned and slower growing types with good drought tolerance.

1.3 Willow clones for New Zealand situations

The willows in New Zealand can be divided into three broad groups: tree willows, osier willows and shrub willows.

The tree willows grow up to 20 m high, nearly always with a single trunk (sometimes only short), which can be 60 to 90 cm in diameter. Examples are weeping willow and 'Matsudana' willow.

The osier willows (or basket willows) are medium-sized shrubs forming several stems up to 20 cm diameter, with slender branches and narrow, smooth-edged leaves. Examples are *S. purpurea*, 'Kinuyanagi' and *S. viminalis* 'Gigantea'. The shrub willows (or salallows) are low shrubs to small trees with multiple stems and stout branches. The leaves are oval to roundish in outline, sometimes rather coarsely toothed, hairy and with conspicuous veins underneath. Examples are pussy willow, grey willow and *S. glaucophylloides*.

There are about 300 willow species worldwide, all hardy, deciduous and able to withstand severe pruning.

Tree willows are used for shade, shelter, soil conservation and riverbank stabilisation. Osier and shrub willows are used as windbreaks and for riverbank stabilisation.

Willows are also important for bees, providing pollen and nectar in spring when other food is scarce.

The white willow (*S. alba*) gives beautiful golden foliage in autumn, as does the golden weeping willow, which is also attractive during winter.



Willow block in Taihape hill country

Available willow clones

Tree willows

Matsudana willow (*S. matsudana* or 'Matsudana')

This species has been widely planted since 1960 for soil conservation, for shelter and as an ornamental tree.

Golden Willow (*S. alba* 'Vitellina')

This has bright yellow branchlets, which are more conspicuous with regular pruning. The tree grows to a height of 15 metres and is semi-weeping in habit. It is most useful as a shade tree, and is not affected by leaf-gall sawfly.

Hybrid *Salix matsudana* × *alba* clones

These tree willow hybrid clones are mostly named after soil conservation reserves or properties, some of which were used for evaluation trials that led to the selection of these clones:

Aokautere is a male clone suitable for general soil conservation planting, for river protection planting, and for windbreaks. It grows rapidly and develops into a fairly narrow-crowned tree with a slightly wavy trunk and blue-green foliage. Regrowth from stools is strong and little affected by wind. This clone needs good moisture to grow satisfactorily.

Hiwinui has a rather spreading crown, and is more suitable for general soil conservation planting than for shelterbelts. 'Hiwinui' is male, with bluish green leaves, and is similar to 'Aokautere' in vigour. The lower branches are often pendulous. Regrowth from stools is strong and little affected by wind.

Makara is a very vigorous clone released only for shelter planting. It has a light, reasonably narrow crown, and a faster growth rate and straighter stem form than 'Aokautere', but because it is female and the side branches are quite brittle, this clone is not recommended for general soil conservation and river control planting. The lower side branches do not persist well in dense plantings, but they are retained adequately in single row shelterbelts. Trees of this clone are generally in full leaf until early June, which is 2 or 3 weeks later than the other clones (except 'Moutere').

Moutere has blue-green foliage and the crown is quite dense and reasonably narrow. Stem form is usually straight and the growth rate is similar to 'Aokautere'. Foliage is retained until early June. It is suitable for shelter and, being male, also for general soil conservation planting. This clone has proved to be superior to all others released to date on very exposed sites. It is best suited to moist gullies, as it needs some moisture year round.

Tangoio

This clone was selected specifically for farm and horticultural shelter planting, because of its high wind tolerance and very good lower branch retention. It has a dense moderately spreading crown and light green leaves similar to *S. matsudana*. 'Tangoio' can also be used for general soil conservation planting, but because it is a female clone it should not be planted where seedling establishment could become a problem.

'Tangoio' has performed very well in trials in the South Island and the Greater Wellington Regional Council land management staff report that there are no seeding problems with 'Tangoio' and feel that it is by far the best drought-tolerant hybrid clone, and offers high potential for fodder.

Uses

Soil Conservation: Clones recommended for slope stabilisation and gully control include 'Aokautere', 'Hiwinui', 'Adair', 'Wairakei', 'Tangoio', 'Cannock', 'Te Awa' and 'Moutere'. These have non-brittle branches, and except for the female clones 'Tangoio', 'Cannock' and 'Te Awa', can also be used for riverbank planting.

Shelter: Clones recommended for windbreak planting are 'Tangoio', 'Adair', 'Makara' and 'Moutere'. Although 'Tangoio' and 'Makara' are female clones, they should not cause any problems from seeding unless planted close to rivers with silty or sandy areas amenable to seedling establishment.

Fodder: 'Kinuyanagi' or 'Tangoio' – the choice depends on the region.

The Hawke's Bay Regional Council land management officers use straight 'Matsudana' willow a lot, because farmers find that it does not grow as tall as some of the hybrids, and if undamaged and carefully

managed to avoid heavy side-branching, it generally grows to become a tidier tree.

‘Matsudana’ performs well over a range of sites, being slower than the hybrid forms on good sites but faster on poorer sites. In addition, it develops a rougher bark earlier than many of the hybrids, important to deter livestock browsing. In northern Hawke’s Bay, ‘Moutere’ and ‘Tangoio’ are the best for coastal situations.

Osier willows

These are medium sized shrubs with slender branches and long narrow leaves.

Kinuyanagi (*S. schwerinii*)

‘Kinuyanagi’ is also known as the Japanese fodder willow. It grows as a large shrub or small spreading tree to around 6 metres high. A male clone, ‘Kinuyanagi’ grows very vigorously on moist fertile soils and offers value as supplementary fodder. ‘Kinuyanagi’ is a very useful alternative to tree willows, and it is highly resistant to willow sawfly in the field.

***S. viminalis* ‘Gigantea’**

S. viminalis is the most widespread of the osier willows. ‘Gigantea’ is a male clone, with an upright habit and several even thickness stems. It grows quickly and is useful for fodder.

***S. purpurea* clones**

Booth is a sterile female clone with spreading habit, 7-8 m tall. It is used more extensively than other *S. purpurea* clones. ‘Booth’ has bigger leaves and more greyish green shoots than other clones. Its flexible branches resist breakage.

Irette is a male shrub willow with an upright habit (7-8 m tall) with value for shelter. Although it has low drought tolerance it does grow well at altitude and its dense fibrous root system makes it useful for stream bank stabilisation.

Pohangina is a moderately spreading, very vigorous male clone (7-8 m tall) with slender flexible stems. It is unpalatable to possums and withstands burial well.

Holland is best in gullies and along stream banks. Its growth habit (up to 7 m tall) is similar to that of 'Booth'. It is male.

Glenmark is a multi-stemmed vigorous and spreading tree that grows well on most sites including hill country. It tolerates acidic soils, and is moderately palatable to possums. 'Glenmark' grows 6-8 m tall.

2 Establishing Poplars and Willows

Poplars and willows are usually planted from poles, stakes or wands – sturdy stems that have been grown by experts in plant nurseries, usually over two seasons. Poles are sold when 2 or 3 metres long, whereas stakes/wands are usually 1-1.5 metres long.

Some contractors will also supply poplars and willows as rooted cuttings, as they say that these have established on farms with high success rates (up to 95 percent). The cuttings however, take longer to grow into sturdy trees than do established poles. Browse blocks (for fodder) should be established using 40-50 cm cuttings.

2.1 Identifying the landforms

Before planting any trees a farmer or landowner should plan the operation. Start by gathering information on the soils, particularly depth and moisture content, erosion potential, suitable tree types and their planting requirements to ensure subsequent successful tree growth. Seek local advice from a regional council land management officer, if possible. The harder sites are usually planted only with certain poplar clones that will tolerate the conditions, whereas willows usually fail. Where the soils dry out higher up the slope or on north-facing slopes, drought tolerant species, such as eucalypts, should be planted.

Planting regimes for different landforms

The most basic but critical step before planting any trees is to ensure that the most suitable tree is selected for the situation. Siting of trees for erosion control is largely determined by existing erosion levels.

Why trees are planted

Objectives for growing trees can evolve over time – trees planted originally for erosion control can be used later for shade and shelter, drought fodder in dry summers, and will still protect a sensitive site.

An experienced operator is probably best at matching tree attributes with the soil type and erosion potential of the site, and local land management officers are the most suitable contacts for advice.

Some regional councils offer a service where the land management officer will visit a property to inspect the site designated for planting and will draw up a colour-coded planting plan, and when the poplar and/or willow poles are delivered they are colour-coded to match this plan.

The descriptions of the poplar and willow clones in these guidelines indicate what types grow well.

These are a general guide for initial selection of trees but check with a local land management officer or tree nursery specialist before buying and planting them.

As with anything on the land, experience acquired on a property improves the results over the years.



A poplar pole nursery

Spacing poles and trees

It is probably easier to consider pole or tree spacing by the distance apart rather than by the number per hectare. Land areas that are more erosion-prone should be more closely planted at the start and then thinned later. Planting at 15 m apart (50/ha) is usually considered to be the lowest density, and 10-8 m spacing (100-150/ha) is more preferable.

Farmers should talk to regional council land management officers about spacing poles/trees. Closer spacing gives effective erosion protection quicker than wider spacing, but it ought to be followed by thinning before the trees are ten years old.

The other steps to take before tree planting involve repairing eroded gullies and slips to some extent– otherwise the trees may be washed away before they can establish.

Land management personnel will also be able to advise the most suitable approach for this repair work. New Zealand researchers and farmers have developed some effective lower-cost methods, such as building debris dams and terracing steep faces, which will reduce or halt further erosion and enable the planted trees to grow and stabilise the damaged area.

Planting of poplars and willows is usually undertaken on New Zealand farms as either open or closed planting. **Open planting** is carried out without a fence and poles are protected with sleeves, whereas with **closed planting** an electric fence is positioned around planted poles to exclude livestock or manage the grazing of the paddock that contains the poles or growing trees.

Gully planting

In hill country, previously eroded gullies should always be planted first as they often lead to more widespread erosion. Willows are well suited to planting in gullies because they develop a fibrous root mat.

To confine water flow within a gully, willow poles were planted in pairs opposite each other, to restrict the water flow to a channel between them, so that the water flowed over the root mat, thereby avoiding the channel being scoured. However, in some regions trees tended to push each other over so pair planting has



Gully planting with poplars in Hawke's Bay

been discontinued. Instead, plant poles 8-12 m apart to give them enough space for growth and alternate them along each side of the gully. This is still effectively joining their root systems but gives the trees more room to grow.

Gully heads sometimes develop a pronounced drop that usually progressively moves upwards and causes more erosion. Building a wooden chute or flume to carry the water over the drop can prevent this. Willow poles planted in rows or clusters at reasonable spacing on either side of the chute will help to filter heavy flow during storms, and non-erodible material (rocks or old tyres) should be placed under the chute end to prevent scouring.

Tunnel gully erosion (narrow underground gullies cut by rainwater into the soil surface) can develop in some hill country soil types and must be stopped to prevent dangerous ‘under-runners’ – tunnels that develop underground when the water reaches a less-permeable soil layer. Lambs can easily be lost in these tunnels and they also cause farmer accidents, especially with motorbikes. Planting poplar and willow poles along these tunnel gullies will resolve the problem and serve to identify the hazard while they are establishing.

Tunnel gullies are rare in some regions, but when they occur, farmers have successfully planted them using long poles. As the layer into which they need to be planted may be 2 m below the general ground level, they should be either 1 or 2 m longer than usual to be above the reach of livestock standing on the paddock surface, or fenced off till they are well established. Under these conditions trees are reported to perform well as they respond to the concentration of moisture and nutrients.

Shallow slip planting

For open planting of slips it is wise to consider planting poles at 15 m centres and adjust the spacing closer with increasing severity of erosion on the site. Spacing should decrease to 8-10 m apart. Root excavation research suggests that plantings should be at 10 m centres with thinning after 8 or 9 years to a wider spacing. Higher density planting is favoured over lower density planting because root spread takes so long.

All slope planting should start in the gully and work up the face. With shallow slipping generous oversowing with pasture seeds is usually recommended, as pasture cover along with tree planting is a better

preventative for further slipping. Choice of willow or poplar poles would depend on soil moisture levels, aspect, and soil depth, and which clones to use would also depend on the local microclimate.

Earthflow planting

Earthflow is normally a result of deep ground instability, frequently exacerbated by subsurface water flow from uphill sources. Rather than treat the earthflow problem, it may be possible to stem the ingress of water by planting trees on source areas, or diverting the water by other means, and dealing with the earthflow itself once movement has slowed. Successful pole plantings have been achieved on such landforms, and these have been reasonably effective for erosion control.

The pole planting density depends on severity of the movement. In some cases it may be better to consider plantation forestry, or even doing nothing, because in some erosion situations this is a viable option. Consult a land manager when planning earthflow planting.

2.2 Pre-planting preparations

Before any trees or poles are planted it is important to ensure the area to be planted is stock-proof or that the planted poles will be suitably protected while they establish and grow into trees. Any electric fences should be free from shorts as far as possible – keep the grass short under and around the fences. If browse or coppice blocks are being planted then the block should be fenced beforehand.

Planting requirements

Place orders from the tree nursery well in advance of planting (preferably the previous year) to ensure that the stock is available and of good quality. Prepare to control rabbits, horses, possums, deer, goats and hares.

Weed control should be undertaken well in advance, especially for gorse and blackberry, as any residual herbicides may affect the newly planted trees.

Herbicide spraying may reveal just how clear an area is for planting, and presence of rocks and roots may force some planting sites to be moved.

Some herbicides may be sprayed before planting. Your rural supplier should know which chemicals are suitable and unsuitable. Avoid herbicide use on lighter, flood-irrigated soils if possible, as water can carry herbicides into the tree rooting zones and kill them.

Planting material is available either as vegetative cuttings or possibly as seedling/rooted material:

Vegetative cuttings are produced by most regional council nurseries. These are either:

- **Poles** – normally sold as 2, 2.5 or 3 m stout poles. Three metre poles should be 30 mm in diameter at their top end and 55 mm across at the base; the 2.5 m poles should be 25 mm in diameter at their top end and 40 mm across at the base; and two metre poles should be 25 mm in diameter at their top end and 35 mm across at the base (diameters quoted are minimum diameters).
- **Stakes or wands** – 1 m wands/stakes should be 20 mm across at the top and 25 mm diameter at the base, and 0.75 m wands/stakes should be 10 mm across at the top and 15 mm diameter at the base. These are usually grown and used for riverbank planting.
- **Cuttings** – usually 40-50 cm long and 15-25 mm in diameter. These are used mainly in nursery plantings and for growing browse blocks.

Rooted stakes – used by some contractors, especially in the southern South Island regions, as prices are similar to those of stakes. The contractors say that these have established really well on farms, but they take longer than poles to grow into vigorous trees. As with poles, rooted stakes/cuttings need to be fenced from stock for protection.

2.3 Planting poles

Essentials of pole planting

- Ensure that poles are planted in suitable sites – in moist soils or depressions where they will grow well.
- Plant them at least 60-80 cm deep – up to a third of the pole length.
- **Ensure they are protected from livestock.**
- Sleeves should be well secured on each pole.
- Keep poles tight in the ground – if they loosen, any roots will break and poles will die.
- Remove and reuse sleeves from any dead poles.
- Look after the growing poles – they are worth caring for.
- **MAKE SURE the pole is the right way up!**

Protect the bark An essential precaution when transporting poles is to protect the bark from damage or the pole can become diseased and dry out more easily. Use straps, ropes and protective pads, rather than chains, when securing a load of poles and unload them carefully.

Before planting Slice the lower end of each pole at an angle of 40-60 degrees so that it can absorb water, and then soak these ends for 8-12 days, preferably using fresh-flowing water and definitely not stagnant water, to ensure they are full of water at planting time. The pole points are normally sliced to a point in the nursery prior to supply.



Poles establishing in Wairarapa

Poles left horizontal with overhead sprinklers on them will achieve better wetting over a seven-day period. Vertical stacking of poles is an option but water uptake is not as successful.

Planting tools Poles can be planted by using a spade and a soil-ramming tool, or by using a special pole-planting bar. Three-metre poles need a planting depth of 80 cm.

How many poles can you plant in a day? Depending on the conditions, an average planter can plant 50 to 80 poles a day. Don't take more out to the planting site than you can plant in one day. Leave the rest where they are being kept moist.

Check them during the first season After planting, rock the poles gently during the first season to check that strong winds, soil shrinkage or even stock rubbing has not loosened them, creating a wider hole where they were planted. If there are such gaps, then re-ram them tight. Should they need re-ramming, do it carefully using a regular fencing rammer and take care to avoid damaging the bark and emerging roots. If drought is likely then spray-release them from surrounding grass with a suitable herbicide to reduce competition for soil water.

When to plant

The best season for planting poplar and willow poles (and other trees) is the cool season from June to August, when soil moisture levels are high, temperatures are lower, and deciduous trees are dormant.

It is important to plant poles into a moist soil, and it is vital to compact the soil after planting to ensure that the pole is firm in the ground and in good contact with soil moisture. Be sure to read any information that comes with the poles, or obtain some from the supplier. If digging with a spade is required to plant a pole, this is much easier to achieve when the soil is moist and more friable.

Where to plant?

Poplars and willows are suitable for planting where the soil will retain moisture particularly over the dry season. Eucalypts or other drought tolerant species should be planted where the soils dry out higher up the slope or on north-facing slopes.

Propagating on-farm material

On the farm it is nearly always the case that using the best tools for a job will produce the best results, and this is the general rule when it comes to selecting poplar and willow poles. While farmers have found that it can be much cheaper to cut poles from suitable poplar and willow trees on their own properties, it is crucial to select material that is straight, well grown and has a suitable diameter or the resulting growth will be much less vigorous and will take much longer to grow into useful trees.

Poplar or willow pole nurseries on farms should be situated on deep moist soils with good shelter to yield good poles. Regional council nurseries are usually situated on prime horticultural soil and this is cultivated and fertilised before cuttings are planted. In general, the younger, thicker and fresher cut the pole, then the faster it tends to establish.

Using home-grown material

It pays to use the basic rules for propagating willows and poplars:

- Harvest main stems rather than side branches.
- Delay harvesting them until just before planting is scheduled.
- When storing is necessary, soak them in clean running water.

Where farmers cut poles on-farm they ought to select the youngest wood possible, at least on the top of the pole. Poles from regional council nurseries often have two-year wood at their base and one-year-old wood at the top, with live buds. Even if these buds are damaged, new buds will burst through the younger softer bark more easily than through the older, woodier bark.

Be sure to label propagating material with the correct clone name. Laziness in labelling can often lead to poles being planted in unsuitable situations.

The top-class poles grown by regional and district council nurseries and by specialist private tree nurseries will usually give the best results on the land, because these people have the most experience at growing the poles and take pride in their material. They pride themselves on achieving good results for the client and supplying the right grades for the job required.

When poles or stakes are delivered to a property, make sure that their labels remain on the material until after planting – and keep a plan of what clone has been planted at each particular site, for future reference.

2.4 Establishment tools

There are several tools to make pole planting easier. Ingenious farmers/tree growers developed their own pole-planters but an alternative option is to use a posthole borer with an auger just big enough to create the right-sized hole for a pole. Although it involves carrying another tool around, most contractors use a separate crowbar, or a motorised auger. In almost all cases a small pilot hole less than the pole diameter is formed into which the pole is driven to the required depth. This gives excellent contact between pole and soil.

Making a large hole in clay soils and trying to re-ram the soil results in shrinkage as the soil dries. Land management personnel say they have not been troubled with holes glazing due to boring. This may occur, however, but when farmers are achieving at least 95 percent survival in most seasons, such a problem is hard to detect.

Borers are most effective for larger diameter poles and drier soil conditions. They can be a one-person or two-person type, with handles to hold them while the auger rotates and drills into the soil, bringing up loosened soil to the surface. Augers of 60-100 mm diameter are recommended.

When using them to plant poles, be sure to restrict the auger diameter to a size broad enough to enable the poles to be inserted. Poles should still be driven in with a thumper, the slice point being firmly anchored. Take care to ram the soil tightly around the pole.

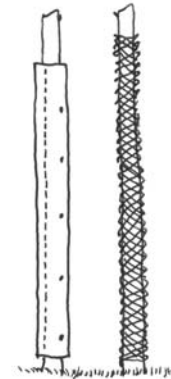
2.5 Pole protection during establishment

Sleeves are recommended to prevent grazing stock and wild animals eating the bark and killing the tree, and rubbing against the bark and loosening the pole.

Two commonly used protective sleeves are commercially available for use on poles – Dynex and Netlon sleeves. These are designed to prevent grazing stock eating the bark off the pole. In practice cattle should not be grazed in

blocks with newly planted poles, even though they may be described as protected by ‘cattle sleeves’, as cattle will rub against poles and push them over while they are establishing. Cattle should be excluded for at least one and preferably two growing seasons. The term ‘cattle sleeves’ is somewhat misleading.

‘Dynex’ sleeves are made from an extruded plastic tube that fits over each pole. The heavy plastic sleeve helps to protect poles from stock damage during the establishment years and can minimise moisture loss when dry winds prevail. The new ‘Dynex’ type has a diamond cut zipper, which splits as the tree’s diameter expands. However it pays to regularly inspect all poles and ensure that this is occurring. Any discarded sleeves should be recycled. Possums find it difficult to climb the new ‘Dynex’ sleeves. If the expanding pole does not split the sleeves, remove them when sheep or cattle are not grazing the paddock, as the bark stays soft under the sleeve. It can take up to two months for the bark to harden.



Dynex Netlon
Sleeves

‘Netlon’ sleeves are made from plastic mesh. They are suitable where sheep are the only stock having access to the poles. Place the sleeve on a pole before planting, pulling it up over the pole base to around 70 cm from the butt end and secure it there, using two vertically aligned staples placed about 150 mm from either end (very important). In this way a ‘Netlon’ sleeve will act as a planting depth guide. As the pole grows into a vigorous tree the sleeve will break down and fall away. Be aware, however, that in areas with high possum populations this protection will not be adequate.

If ‘Netlon’ sleeves are unattached and fall off by themselves, stock grazing the area will damage the soft bark. Hawke’s Bay Regional Council land management officers say they use 1.7 m long sleeves in both ‘Dynex’ and ‘Netlon’. They generally put ‘Netlon’ sleeves on first (up from the bottom because of the trimmed branch stubs) but do not fix them, as pole planters have often struck hard material before the pole was rammed right down, leaving the sleeve suspended above the ground.

‘Netlon’ sleeves expand as the tree develops and remain on tree trunks for years. Rolls of similar material can be bought, cut to size and tied with

string. Ensure however that the planting rammer will fit over the pole and sleeve! An alternative is to spray paint the pole at the planting depth as a guide. The easiest way to do this is to lay the poles side-by-side and spray at planting depth across them all in one burst.

Apart from using protective sleeves livestock can be excluded by erecting **electric fencing** around the planted poles. This is easily done and will effectively prevent damage from domestic stock as most stock on a farm respect live wires. However if possums, rabbits and hares are present, 'Dynex' sleeves provide better protection.

2.6 Browse blocks

A browse block is generally sited on an unproductive wet and rush-infested area of the property. This is fenced and closely planted with short but stout willow cuttings and allowed to grow until it can be safely grazed. Once a browse block is established the soil becomes drier and the pasture understorey improves and may become legume-rich. The block can be grazed two or three times a season to maintain the balance between willows and pasture.

Willow browse blocks raise the productivity of wet sites. They may also be grown on highly productive alluvial flats prone to erosion through flooding. Small nursery areas can be used to grow cuttings for establishing other blocks, and can also be browsed to supply supplementary fodder when needed.



A browse block in Hawke's Bay

Willow is preferred for browse blocks because it grows more and thinner stems than poplar. This results in trees carrying more leaf material and finer laterals, which supply the browse fodder. Stock generally keep the shoot height to a manageable level, reducing the need to trim shoots mechanically.

For converting a wet area to a browse block, willow cuttings 40-50 cm in length and with a diameter of 15-30 mm provide sufficient material to establish healthy plants. The main limitation for plant establishment is available water. It is best practice to spray the rows with herbicide before planting to eliminate competition from grasses. The cuttings should be planted to a depth of 25-35 cm, leaving 15-20 cm above ground. This produces browse fodder at an accessible height for lambs.

Wet areas are usually catchments for surrounding hills, and so accumulated nutrient inputs should be sufficient to fertilise the browse block. Being wet, they will probably also contain resident clover and lotus, legumes that tend to thrive under browse block management and supply high quality feed along with the tree fodder. Though soil moisture is high it is best practice to spray herbicide along the rows before planting.

The herbicides glyphosate (mostly available as 'Roundup') and terbuthylazine (available as 'Guardoprim') are recommended. Apply at the standard recommended rates for glyphosate (see the container instructions for the particular brand) and 3 litres/ha of terbuthylazine. This is equivalent to 300 ml of terbuthylazine in a 15-litre knapsack sprayer using a fan nozzle.

Herbicide names and rates

In using the herbicide brands mentioned in this text we intend no endorsement or criticism of these products or of any others not mentioned. The brand names are only used to make reading easier. The rates refer to product per litre, rather than active ingredient per litre.

For killing pasture around the tree after planting a browse block, the non-selective contact herbicide glufosinate-ammonium (known commercially as 'Buster') is suitable at 200 g/litre. Though this herbicide has a half-life of 3-20 days in the soil if not taken up by roots, any spray drift onto a tree is not as serious as with glyphosate.

Cuttings are usually hand planted, inserting them into soft wet soils or areas that may have been ripped or cultivated. One farmer has successfully laid partly covered cuttings horizontally in wet areas, and the cuttings have sprouted at each node along the length, growing into a denser browse area. However, although horizontal planting works, it is best to establish a strong root base to supply the foliage growth and for ease of access for stock and

harvesting, and this is why vertical pole planting remains the most suitable way to establish poplars and willows. Well-designed pole planting tools, such as a stake bar, should be used for planting.

Spacing can vary widely. Some North Island areas have been planted at 1.2 m by 1.2 m spacing (approximately 7,000 stems/ha), and others at 3 m by 3 m (approximately 1,100 stems/ha). In the South Island plantings up to 12,000 stems/ha have been reported. Wider spacing favours pasture growth, which then needs to be managed, running the risk of damaging the browse trees before they are properly established.

The key elements for deciding spacing are wheeled access between the rows, and sufficient trees to maximise fodder production. For this, planting in single rows spaced 1.5 m apart will work well, depending on the need for access (measure the width of a four-wheel farm motorbike) and additional pasture, and with cuttings planted 75 cm apart in the rows (approximately 9,000 stems/ha). The greater density increases competition between willow plants and reduces their stem diameter and inedible wood production.

Having planted stakes during winter, and excluded livestock from the block with reliable fencing over the first spring and summer, the browse block can then be browsed with sheep or cattle in the following autumn (about April) to minimise vertical tree growth and control the pasture understorey growth. Later in autumn cut any remaining tree shoots with a scrub-saw or similar equipment, to leave stumps about 15-20 cm above ground.

During the winter after planting continue with sheep grazing through to early spring (bud break) to control the pasture understorey growth. In the second spring after planting a browse block, grazing lightly once or twice will be possible, once the new season's shoots have developed to a reasonable size.

Before leaf fall, spell the willows to enable them to accumulate reserves in their root systems before becoming dormant during winter.

2.7 Coppice blocks

Poplars and willows grow quickly in wet areas, establish extensive root systems and remove large quantities of water. Their ability to coppice repeatedly makes them promising candidates for use in effluent irrigated

systems; either as vegetation to be directly irrigated by the effluent, or as riparian buffer zone plantings to capture nitrogen from seepage or re-irrigated tile drainage.

The coppiced material must be cut and carried to stock, either milking or dried-off cows, or other livestock to disperse the nutrient.

If used for effluent nutrient uptake, blocks should be located on land accessible to the effluent irrigation system.

Flat land is preferable but gentle slopes up to 5-10 degrees may also be suitable. After early spring, soil moisture levels are usually depleted by sun and wind, and so effluent runoff into drains becomes less of a concern.



Coppiced willows

There is also more active growth of pastures at this time, which assimilates more nutrients.

The effluent returned on these coppice blocks will raise soil nutrient levels. In theory, the trees ought to absorb the applied nutrients at the same rate as they are distributed on the area, to prevent leaching into groundwater and run-off into streams. In practice this nutrient balance can be difficult to determine due to variations in soil type, pasture cover and the local climatic conditions.

For example, annual rates of up to 400 kg of nitrogen/ha were recorded being uplifted by a 'Tangoio' willow coppice block in a trial at Carterton, Wairarapa.

The procedure for planting effluent coppice blocks is the same as described for browse blocks though high planting rates of 12,000-15,000 stems/ha are recommended, to increase nutrient uptake and reduce competition from pasture. The plant material used will also be similar, as will methods used to plant them – although access should be much easier on these sites.

However abundant foliage is needed to ensure maximum nutrient uptake, and layout is important to enable any irrigator movement and harvesting by machinery.

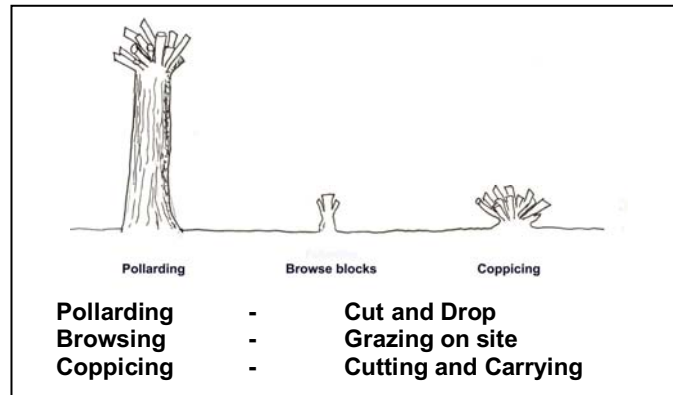
Advice on establishing effluent coppice blocks should be sought from your local land management officer.

Livestock should be excluded from effluent coppice blocks because the trees will be cut by machine and transported to an adjacent pasture area for consumption by livestock.

Controlling the pasture understorey growth during and after the trees are established may be an issue in an effluent coppice system. Possibly herbicides used in timber plantations for controlling understorey growth may also be used on these blocks after coppicing and before the next growing season.

3 Managing Poplars and Willows

The main methods used by farmers to manage poplars and willows are **form-pruning**, **pollarding**, using them as **browse blocks** and **coppicing** them for effluent nutrient uptake. The three latter methods are used to prevent these trees from becoming too big and potentially dangerous.



Pollarding is a very old technique for limiting the above ground size of a tree and promoting leafy growth at the expense of woody growth. It is widely used for street trees and in parks and gardens, and has been adapted by New Zealand farmers as a way of using poplars and willows planted for soil conservation purposes as drought fodder.

Trees in any system can be pollarded by sawing through the main branches or the single trunk at shoulder height or higher (to prevent cattle browsing the early regrowth). For safety reasons this operation should be carried out either from a cherry picker (or a tractor with a front end loader adapted to be used as a cherry picker), or from a forestry ladder roped to the tree trunk, or safer still, from ground level.

The older the tree, then the more dangerous this operation can be, because willows especially tend to suddenly break when being pollarded. This is known as 'barber's chair' because part of the branch or trunk remains vertical, resembling the back of a chair.

Farmers carrying out pollarding should take a proper training course with forestry specialists before tackling the job themselves.

The trees may be in a regular or irregular planting pattern. Many trees planted for soil conservation may also be pollarded and harvested regularly or occasionally for fodder supply.

A poplar or willow block may be planted on gently sloping land specifically for fodder use. However pollarding is usually practised on trees that have been planted to prevent soil erosion through slipping on hill slopes, or along waterways to maintain water quality. In most, if not all cases, the fodder is supplied to stock in a cut-and-drop operation, without any cartage.



Pollarded poplar trees in North Otago

3.1 Pruning equipment

Good protective equipment is available from reliable tree specialists, and this is usually the same as that used by forestry workers. A good range can be seen at the website: www.timbersaws.co.nz.

It is much safer and easier to prune poplar and willow trees when working from ground level. Saws and loppers are available with long extension handles, to use on upper branches of smaller trees while standing on the ground, and even chainsaw work can be done from ground level. Doing this however, might need different animal management after pruning.

Keep cattle out of the paddock while pruning. One farmer reported that he had been marooned up a tree on three occasions by cattle knocking the ladder over while consuming the prunings, so he has since ensured that the ladder is always roped to the tree when cattle are present.

Use the right equipment

Experienced farmers have adopted the following standard equipment for tree pruning:

- Hard hat with muffs and visor.
- Chaps for leg protection.
- Special forestry boots – not just the normal steel-toed farm boots.
- Compression bandage pack and comprehensive first aid kit.
- Mobile phone (where reception is available) or other effective communication equipment.
- Fire extinguisher (pruning is best done in dry summer weather).
- Forestry pruning ladder and a strap to secure it to the tree.
- Pruning harness.
- Adequate drinking water.
- Short length of rope – for lowering the chainsaw or the operator.
- Efficient top-handle chainsaw (high-speed pruning model).



3.2 Sleeve removal

The Dynex sleeves split as the growing trunk exerts pressure on them, and while the bark remains soft for a few weeks after shedding, progressive shedding reduces the area of vulnerable bark exposed.

Farmers should protect their trees from bark damage following the removal of the sleeve. Brief grazing spells among young trees are recommended, especially when pasture feed is scarce. Netlon sleeves stretch and break as the tree trunk thickens. The bark under Netlon hardens by itself because of the greater exposure to weather. Using electric fencing to isolate exposed young trees is worthwhile. The biggest reported risks are with browsing by bull beef herds, especially rising two-year-old stock, and Friesians are reported as causing more damage than other breeds.

3.3 Form-pruning poplar for timber

Poplar trees can be pruned for eventual timber production while still providing erosion control and fodder during droughts in their earlier years. Remember that silviculture aims to maintain tree health and to keep trees in good shape.

Begin form-pruning trees at around 5 years after planting them as poles, depending on their growth and local wind exposure. This may check root development for a short period after pruning but the extent of this remains to be determined.



Poplars grown for timber in Hawke's Bay

When a tree is growing well it can be pruned after 4 years, but if it is growing slowly or in an exposed position, waiting until the 5th year is preferable. When pruning these young trees for timber production, aim to develop a healthy tree with a single leader. This will also reduce the wind loading on the tree.

The first pruning for a tree should reduce the leaders to a single leader. Prune the lower two whorls of branches at two years after the first pruning, and then every year thereafter prune off a whorl of branches up to a height of 6 m. Pruning trees in this way will develop a tree with a straight form and a good potential for timber use, especially for poplars.

Remove any large ramiforms (steeply angled vigorous branches) as early as possible, as these are likely sites for splitting in old trees.

For timber trees, continue to remove the lowest whorl of branches until there is at least six metres of clear wood developed (the butt log). Remove any

regrowth from the trunk each year. As a guide it is advisable to retain a minimum of three years of green crown (three major whorls).

Prune the trees in autumn to minimise epicorms (small shoots that develop on a tree trunk) regrowing on the main stem. Epicorms are an issue in early pruning since plenty of light penetrates to the lower levels of the trunk.

3.4 Coppicing for effluent management / fodder

This concept is still under evaluation and so far as is known, not in use on any farm yet. A trial was undertaken as part of a MAF Sustainable Farming Fund project on a dairy farm near Carterton, Wairarapa during 2001-04 and a further trial has been conducted near Balclutha, Otago as part of this SFF project (2004-07).

Coppice blocks for this purpose would be planted on smaller areas near a dairy farm's milking shed to enable regular effluent application with minimal effort. They are intended for absorbing potential pollutants from dairy effluent, such as nitrates and phosphates, extracting them from the soil and storing them in plant biomass before they can pollute local waterways through surface run-off or leaching into groundwater.



*Effluent management block in South Otago
(Photo: Malcolm Deverson)*

An irrigation system is used to apply the effluent. There is evidence from trials that poplars and willows can readily absorb dairy shed effluent nutrients. The harvested foliage, if not coated with effluent, could be a valuable supplementary feed during dry summers when feed quality of

ryegrass-based pastures is reduced and livestock disorders like ryegrass staggers and facial eczema often threaten herd health.

Irrigation would begin late in spring and continue until late autumn when cows are dried off. The trees are irrigated with fresh effluent using a suitable irrigator down the centre of each coppice block so that minimum effluent is sprayed on the tree foliage. This avoids making the fodder unpalatable to livestock. Irrigation frequency will depend on the runoff from the milking shed and water may need to be used when the foliage becomes coated by effluent. The trees may need a water wash after irrigating with effluent to prevent the latter drying on the foliage. Using K-Line irrigation or installing a border-dyke system may minimise this problem.

Tree growth in these blocks is rapid because of the high nutrient return, and the irrigated trees soon form a closed canopy. One potential problem with poplars could be rust infestation helped by the moist conditions (rainfall and regular irrigation) during much of the growing season. These trees would probably be harvested using machinery as a traditional coppice – to 15-20 cm above the soil surface, and the foliage fed to cattle, probably to dry stock on-farm or off-farm. However cattle could still graze them, preferably using dry stock.

Willow is more suitable for use in this system, because of its longer growing season and a higher foliage-to-wood ratio and nutrient uptake than poplar. However, using willow and poplar in coppice blocks for effluent management on dairy farms will depend on long-term growth rates. When their growth rates are high, more effluent could be applied to a coppice block than to pasture without increasing leaching. This would reduce the land area required for irrigating effluent – an advantage on farms where soil type or topography restricts the area suitable for irrigation.

Nutrient uptake should match the nutrient quantities applied to prevent any leaching into waterways. These trees are deeper rooting than pasture plants, so they could be valuable during wet weather where storing effluent is not practicable or where there are heightened concerns about the effects of nitrate leaching, such as in the Lake Taupo catchment. Coppice blocks can be used in conjunction with on-farm effluent storage facilities.

The Otago trial is using the K-Line irrigation system with great success, as this accurately applies up to 5 mm of liquid effluent per hour. In the trial the irrigator lines were about 15 m apart running in parallel lines to one another.

They were also stationary. Risers at 1.5 m high enabled the effluent to be spread over the low willow shrubs.

An advantage of coppice blocks is that they accumulate large fodder quantities with a feed quality similar to that of maize silage. This feed is available in late summer when many farms experience feed deficits. Organic farmers may also appreciate fodder from coppice blocks as a possible option for minimising parasitic worm effects in livestock.

3.5 Pollarding for supplementary fodder

Willows and poplars can tolerate regular defoliation and quickly regenerate to supply future supplementary fodder. Several pollarded willows that have been harvested every 2 or 3 years on farms since the early 1980s are still growing as vigorously today as they were 20 years ago. Furthermore, the farmers observe that they recover enough for soil conservation (no erosion problems have been seen near these trees) and they continue to supply some shade for stock until the next pruning.



Some 20-year-old willows have been pollarded at least six times in their lives, and the farmers say that many cattle and sheep have appreciated them meantime as forage and shade. A mature tree with about five year's regrowth can feed up to 30 cows for a day. When fed along with hay, one large tree can feed about 60 cows. In a recent study in Hawke's Bay, regrowth from a willow tree pollarded (complete canopy removal) five years earlier was 29.3 kg dry matter, of which about 30 percent comprised edible foliage (leaf and stem less than 5 mm diameter).

The branch debris left around the trees after pollarding can be a nuisance, in that some weeds can germinate in its protection and debris can also be a hindrance when mustering livestock. Poplar and willow limbs tend to degrade very slowly, especially the heartwood, and some animals have been reported as becoming trapped and found dead in non-decayed pruning debris. However, if the tree is on a reasonably accessible site, the debris can be cleaned up and used as

firewood. Willow and poplar make perfectly acceptable firewood if not left too long on the ground and burn as well as any other timber in an efficient wood burner.

Cattle will strip leaves and bark from willows and poplars and eat stems up to 10 mm diameter. Sheep tend to consume leaf and small stems up to 5 mm diameter but do not generally strip much of the bark.

The decision to harvest poplars needs to be made reasonably early in the season, before the trees start shedding their leaves in response to the drier conditions. In general, farmers in these regions say that poplars should be harvested first, and willows should be saved for later use. Some farmers have created a dedicated fodder block on flat or gently sloping land with a good water supply. This ensures that the fodder retains high nutritive value during drought, can be harvested easily and quickly, and the debris is more easily removed afterwards.

Different willow and poplar types as fodder trees

On a Hawke's Bay sheep and beef farm, 'Matsudana' and 'Pussy' willows, and a line of 'Flevo' poplars, were planted in 1985 on an open moist area that was accessible and had a reasonable water supply nearby. The trees were pollarded at cattle height within four or five years and used specifically for supplementary fodder during summer. The 'Flevo' poplars and 'Matsudana' willows are still being used to supply fodder (2007) in a 2 or 3 year harvesting regime. The 'Pussy' willow's soft and palatable bark made it an easy target for ring-barking and ultimate failure.

'Flevo' poplar is recommended as a fodder resource because it grows a multitude of branches and large leaves. 'Kawa' and 'Toa' poplars could also be used as complementary planting with 'Flevo' since they hold their leaves later in autumn. However, several other poplar types and selections can also be pollarded for drought fodder. All poplar varieties are palatable when animals are hungry, even the more bitter types selected for possum resistance.

Managing browse blocks

These are high density plantings at anywhere from 4,000 to 10,000 stems/ha (and beyond in some regions), and as their name suggests, they are browsed directly. There is no cut-and-drop, or cut-and-carry.



Willow browse block near Masterton

Some blocks are seen on private farms/stations and Massey University's Riverside Farm near Masterton has several experimental browse blocks, which can be viewed during field days.

Following planting the cuttings in late winter, the block could be browsed lightly in the following autumn (about April) with sheep and/or cattle to reduce the tree growth and control the pasture. In late autumn (about May), the tree shoots could be tidied by cutting them with a scrub-saw or some similar implement to approximately 0.5 m above ground. Using cattle to lower the tree growth level may be an alternative option.

In the winter after planting continue with sheep grazing, possibly through to early spring (bud break) to control the pasture growth. It may then be practical to lightly graze the established block once or twice when the new shoots have developed to a reasonable size. The manager should try to reduce early spring grass growth as much as possible to minimise the risk of high pasture dead matter content later in the season.

During the third year onwards, it is recommended to operate the same system – browsing with cattle/sheep in autumn, then giving sheep access in winter/early spring, and perhaps once or twice during spring – aiming to maximise the benefit of the browse system for supplying feed in summer/autumn drought.

Provided the browse block is managed well, it ought to persist for at least 10-15 years and possibly longer. This depends on the soil type, the tree clone planted, the management it receives, weather patterns and prevalence of pests and diseases.

3.6 Poplar management

Poplar trees may be planted for several purposes – soil stabilisation, shelter, shade, timber, fodder and firewood. Regardless of the purpose, trees will benefit from an active, planned, systematic management programme. When not managed properly, poplars will be less likely to meet the landowner's needs, whereas given regular maintenance, poplar trees will provide long-term land protection without becoming dangerous. Suitable pruning will help to develop a stable and beautiful site with healthy trees in a pasture that will provide grazing. An added incentive could be the financial return from poplar timber when the trees are mature.

Poplar poles are best planted at a high density to achieve earlier soil stabilisation. However, after about 10 years their density can be reduced. Livestock frequently congregate under shade trees. Pruning reduces the shade cast by a tree, but with pruned, narrow-crowned trees, the shadow is positioned further away from the trunk, preventing bare patches under trees. Any bare understorey is a good indication of over-planting. Thinning will improve the situation and is unlikely to increase the site's susceptibility to erosion.

Replacement planting and management

As conservation trees grow, and are not being managed for stock fodder, fewer are needed to provide adequate root protection of the slope. The landowner should then selectively thin a stand to its desired density, which will be in the range of 25-100 stems/ha. If no replacement management regime is implemented, these trees will all be of the same age and could generate problems when they mature. It is therefore advisable to plan a rotational planting programme to ensure that only a quarter of the trees are mature at any one time. If we assume a 40-year life for the tree, then a 'fell and replant' programme should take place every ten years.

At the tenth year following planting, trees that are too close or growing poorly can be removed and used for fodder and firewood. The gaps are then filled with new trees. This process will be repeated every 10-15 years, depending on tree growth, giving a sustainable stand of protection planting.

Root growth

One point about pruning these trees – remember what is happening to the root system below ground when timing the first branch pruning. Joint excavations by AgResearch and HortResearch staff have determined poplar root growth at Ballantrae, AgResearch's hill country research station near Woodville. At five years after planting from poles, poplar roots showed negligible growth (in terms of mass and distribution) compared with those at seven years, and particularly at nine years.

Consider the extent of pruning as well, and which parts of the canopy should be pruned. It is important to maintain a good balance between the tree canopy and the root system.

Pruning poplars for timber

Once established poplars can be pruned so that they develop as a timber resource as well as providing those other functions: stabilising soil and providing stock shelter and shade.

Trees put on regular growth increments each year. Whorls describe the position on the stem where a group of branches develops. A new whorl forms each year, so the branches at a whorl represent one year's lateral branch development. As a guide it is advisable to retain three years of green crown (three major whorls) to sustain an acceptable rate of growth. Removing side branches and extra leaders promotes tree stem growth, and while root response to pruning is not known, the stem response suggests that root development is not greatly retarded.

Begin form-pruning trees at around 4 or 5 years after the poles were planted, depending on vigour and local wind exposure. At the first pruning reduce the leaders to one strong leader, and remove any large ramiforms (steeply angled vigorous branches), as these are likely sites for splitting in old trees. Two

years after the first pruning remove the lowest two whorls of branches, and then every year thereafter prune off a whorl of branches until there is at least 6 m of clear wood developed to produce a butt log. Keep removing any ramicorns and any regrowth on the trunk. Applying this pruning treatment will develop a tree with a straight form and a good potential for timber use.

Pruning is best carried out towards the end of the growing season (when the foliage can be used for fodder) to minimise epicorms (small shoots that develop on a tree trunk) regrowing on the main stem. Epicorms are an issue in early times of pruning since plenty of light penetrates to the lower levels of the trunk. Cut surfaces dry out quickly too, reducing the likelihood of fungal disease. A telescopic pole saw is excellent for pruning and has a blade to undercut the branch first so the bark is not stripped when the branch is cut.

Advice from a regional council land management officer will help the landowner to determine the best practice in relation to replacement planting.

Managing a poplar shelterbelt

Poplars are widely used in shelterbelt plantings. The recommended poplar clone for shelterbelts is 'Crowsnest' because of its upright form and slower growth. Regular trimming is needed to maintain control of each shelterbelt. It is preferable that a shelterbelt contractor does this using a tractor-mounted trimmer.

This equipment consists of one or more rotating saw blades on the end of a hydraulic boom, which easily shapes the sides and tops of a shelterbelt and develops a good-looking form in a short time. It has to be done at least every other year once the trees are established and growing.



Shelterbelt pruning

3.7 Willow management

Willows grow quickly and usually with a more open habit than poplars. As the trees age heavy limbs can become distorted while competing with other

limb growth, leading to breakout and toppling. These trees should therefore be regularly pruned by pollarding them, to ensure they perform as required – providing shelter and shade to livestock and long-term protection for erosion-prone land without becoming too large and dangerous. Pruning and shaping develops more stable trees on sites – healthy and safer trees surrounded by pasture that continues to provide livestock feed.

Willows are also suitable for shelterbelts but need regular side pruning by a contractor operating a tractor-mounted trimmer. This shapes the sides and tops of a row of willows and develops a good-looking shelterbelt – but it has to be undertaken regularly - maybe every two or three years. Many willow shelterbelts are still grown around Te Puke in the Bay of Plenty. The trimmings harvested from these shelterbelts can be fed to stock after pruning.

3.8 Dealing with unwanted old trees

Old and very large trees are potentially dangerous to stock and landowners as there is a significant risk of large limbs breaking off in high winds or the tree being uprooted in wet, windy conditions. Recommended best practice is to remove these trees by injecting the trunk with herbicide or employing professional logging contractors to remove them.

Removal is the better option when they are growing near important facilities like buildings, fences and waterways. The cost of this may be significant but it can give a good return if the job is carried out efficiently, and the contractor and farmer clean up well afterwards.



Felling an old tree

A ‘fell and replant’ policy should be adopted to prevent problems and hazards when storms and flooding occur, as access tracks are easily blocked by fallen trees or branches and waterways become blocked by old trees or tree parts that break off. This debris will frequently cause loss of fencing, floodgates and even bridges. This is a potential consequence of

not managing old degrading poplar and willow trees along or close to waterways.

An unplanted site may however carry more erosion debris and hence create more significant damage. Analysis of satellite imagery by researchers has shown that the probability of erosion is five to ten times higher under pasture only than on land planted with trees. Spaced plantings of poplar were found to reduce mass-movement erosion by an average of 22 percent.

Pruning of large trees does not have to be completed all at one time, though it is better to do so. Pruning in late summer, especially in drier regions, enables a farmer to use the trimmings as drought fodder, and its feed value can be similar to that of lucerne hay provided that poplar rust hasn't developed. Removing side limbs also allows more light into the pasture understorey during summer when the leaf canopy is most dense. Furthermore stock will consume much of the younger bark from the pruned branches.

When pruning the heavier limbs during winter, it may be possible to harvest some as poles for new plantings, but older material has a lot less vigour. Any stunted and unhealthy trees should be removed in any case. Cut these at ground level and let the stock browse any regrowth that develops.

Clean up all the pruned branches to prevent them washing into drains or culverts when a storm occurs. Landowners are becoming increasingly liable for downstream damage caused by their activities around waterways.

On an open slope, mature trees at a spacing of 15 m is sufficient to maximise slope protection from earthflows or slips. In areas more prone to erosion, such as gullies or deep earthflows, closer plantings may be more advisable. Discuss any thinning of these trees with your regional council land management officer before proceeding.



Poisoning a tree

Herbicide use

There are numerous large soil conservation trees on pastoral land in New Zealand. These trees are usually older specimens that are too big to fell safely and may leave an untidy mess of toppled debris when storms occur. For such trees, poisoning with suitable herbicides such as glyphosate, terbutylazine (sold as 'Guardoprim') and metsulfuron-methyl ('Answer') can be effective. 'Guardoprim' is sold with instructions for use in tree poisoning.

Herbicide naming

In using the herbicide brands mentioned we intend no endorsement or criticism of these products or of any others not mentioned. The brand names are only used to make reading easier. The rates refer to product per litre, rather than active ingredient per litre.

The preferred approach to poisoning by experienced farmers is to drill holes at a downward angle around the lower tree trunk about a hand span apart, using a motorised drill or auger. Using an auger instead of a chainsaw makes this operation much safer. These holes are then filled with herbicide from a sealed container by using an applicator gun left over from applying pour-on stock dips. Keep the applicator gun for exclusive use in tree poisoning.

The time of year for poisoning unwanted trees is important. Good results are usually achieved when this is undertaken from November through to February when the trees are actively growing. When trees come under drought stress during February however, they may not absorb the poison readily, so avoid doing this operation when such conditions exist. Where trees are growing very closely to each other (only four or five metres apart) the poisoning of one tree may affect a neighbouring tree as 'root grafting' can occur between adjacent trees.

Latest research results

*From Ian McIvor and Carlo Van Den Dijssel
HortResearch, Palmerston North*

This trial was carried out between 2005 and 2007 on poplars of unknown parentage on hill country farms at Kawhatau near Taihape and Kiwitea near Feilding. Selected mature trees (with a mean DBH of 70-101 cm for the

different treatments) were treated with one of two herbicides, either 'Roundup' (glyphosate) or 'Escort' (metsulfuron-methyl) at two monthly intervals starting in October 2005 and finishing in April 2006. Holes 7 mm in diameter were drilled 30 mm into the trunk at a 45° downward slope, at regular spacing right around the tree circumference at waist height and 2 ml of herbicide product was injected into each hole.

Treatment

1. 'Escort' was applied at three concentrations – 0.5x, 1x and 2x the manufacturer's recommended application rate (10g/L, 20g/L and 40g/L) and at 10 cm hole spacing. We also evaluated 'Escort' at 40g/L and at 20 cm spacing, i.e. double the recommended application rate but at double the spacing, in February and April only.
2. 'Roundup' was used undiluted but the hole spacing was varied – either 20 cm, 10 cm or 5 cm apart, these rates also being 0.5x, 1x or 2x the manufacturer's recommended application rate. The sites were visited on 14 November 2006 to assess the effectiveness of the treatments. At this time untreated trees had a full canopy of leaves. The effectiveness of the different treatments is shown in Tables 1 and 2.

Injected trees were assessed, and a further assessment of the trees injected in April 2006 was done on 22 February 2007, since those trees were showing less effect of the herbicide compared with trees injected from October-February when assessed in November 2006.

Signs of effectiveness

The response of the mature poplar trees to the herbicide treatments is summarised in Tables 1 and 2. It was clear that the trees had assimilated the herbicides and that there had been conduction throughout the canopy.

Treated trees lost almost all their leaves by the next treatment date. Where branches still retained leaves we considered that the conducting wood to that branch was carrying less than an effective concentration to kill the tissue in that branch.

At the time of assessment there were other significant signs that trees were not healthy. Smaller branches had fallen off, the bark was easily lifted and in some trees had almost completely fallen off. Most trees treated up to February had weeping fungal and bacterial infections close to the base of the trunk and other fungal infections.

Timing Treatment earlier in the growing season appeared to be more effective than treating trees later in the growing season (April), based on the emergence of leaves in the following season. Despite significant leaf emergence on the trees treated in April, the leaves were sparsely distributed, had later bud burst, were smaller and showed classic signs of chlorosis (lack of green colour in the leaves) and leaf browning around the edges. This suggested that water and nutrient conduction from the roots was severely disrupted. Conduction activity is mainly towards the roots in autumn so resources in the branches may fuel the emergence of a sparse leaf canopy in the trees treated in April, but is unlikely to save the tree.

Table 1. Poplar tree response (rating) after one year to ‘Roundup’ herbicide injection at different times during the growing season (1= low; 5 = high).

Timing	Hole Spacing (cm)	Rating	Recommended
Oct	20	3	No
Dec	20	3	No
Feb	20	2	No
Apr	20	1	No
Oct	10	5	Yes
Dec	10	5	Yes
Feb	10	4	Yes
Apr	10	3	No
Oct	5	5	Yes
Dec	5	5	Yes
Feb	5	5	Yes
Apr	5	5	Yes

A hole spacing of 10 cm is the manufacturer’s recommended spacing.

Application rate The undiluted ‘Roundup’ (Table 1) was effective at the 10 cm hole spacing and even at the 20 cm spacing except at the end of the growing season (April). It is unnecessary to reduce the spacing to less than 10 cm. The recommended rate of 20 g/L applied into holes at 10 cm spacing appears to be sufficient to kill the tree.

Doubling the hole spacing at the same concentration has reduced the effectiveness of the herbicide (based on leaf presence), and though this may

be sufficient to kill the tree eventually, at this stage we cannot be sure and so do not recommend it.

Treatment with 'Escort' (Table 2) at the recommended rate was effective, and therefore reducing the spacing below 10 cm is unnecessary. Doubling both concentration and spacing did not reduce effectiveness when applied in February, but the April timing showed reduced effectiveness.

Table 2. Poplar tree response (rating) after one year to 'Escort' herbicide injection at different times during the growing season (1= low; 5 = high).

*				
Timing	Conc.	Hole Spacing (cm)	Rating	Recommended
Oct	0.5	10	3	No
Dec	0.5	10	5	Yes
Feb	0.5	10	5	Yes
Apr	0.5	10	5	Yes
Oct	1	10	4	Yes
Dec	1	10	5	Yes
Feb	1	10	5	Yes
Apr	1	10	5	Yes
Oct	2	10	5	Yes
Dec	2	10	5	Yes
Feb	2	10	5	Yes
Apr	2	10	4	Yes

* Concentrations used: 0.5 = 10g/L, 1 = 20g/L, 2 = 40g/L; 20g/L is the manufacturer's recommended concentration.

Effect of poisoning on adjacent trees

During this experiment trees adjacent to the poisoned trees were inspected for any evidence of poisoning. There was no damage observed at Kawhatau. However at Kiwitea, two trees 8 m and 16 m from a tree treated in April with twice the recommended dose of 'Roundup' had a leaf canopy estimated at less than 25% of a healthy canopy, the closer tree being the more seriously affected. A third tree adjacent to a tree poisoned with a normal dose of 'Roundup' showed a reduced canopy also, though less severe. These trees were likely to have roots grafted onto roots of the treated tree. Other observers have reported adjacent trees being killed during a poisoning

treatment so proceed cautiously and experiment where it is important that adjacent trees are not damaged.

In summary:

- Glyphosate (as 'Roundup') and metsulfuron-methyl (as 'Escort') are effective in killing old poplar trees when applied by injection into drilled holes at the recommended dosage and a hole spacing of 10 cm.
- Trees should be poisoned between October and February when they are actively growing. The treatments showed reduced effectiveness when applied in April.
- The easiest approach to poisoning big trees is to use a 12-volt cordless drill with a 7 mm bit, connected to a small auxiliary battery. Drill into the tree 30 mm and angle the drill hole downwards at 45° with one hand while injecting 2 ml of the recommended dilution into each drill hole using an old vaccinating gun connected to a supply bottle. SFF Project Leader Peter Gawith has proved this on his farm.
- A tree with a circumference of three metres will require 30 drill holes and 60 ml of herbicide so an auxiliary battery and a litre of herbicide in the supply bottle should be sufficient to poison 15 or so trees at a time.

Herbicide effect on the root system

The presence of small roots on trees that had been poisoned 11-17 months beforehand was assessed and compared with untreated trees. Two pits 30 cm x 30 cm x 15 cm were dug at 2 or 3 m from the trunk of four trees (two from each herbicide treatment), treated on the same date, and the roots present in each pit were collected, classified, and their length and dry mass measured.

A further eight untreated trees were sampled using the same procedure. The treatments chosen were the recommended dose treatments (see above). The trees in this trial were spaced around 15 m apart so the area around any one tree would also have roots present from adjoining trees. Pit sites were chosen to minimise this.

Figure 1 includes live and dead roots to show that some small roots were still present following poisoning, but 70-95% of fine root (less than 2 mm thick) biomass had disappeared by 17 months. The fine roots remaining were short, more than 1 mm in diameter and brittle, so while root mass

showed a 70-95% decline, the root length decreased by 95% from the disappearance of roots under 1 mm thick.

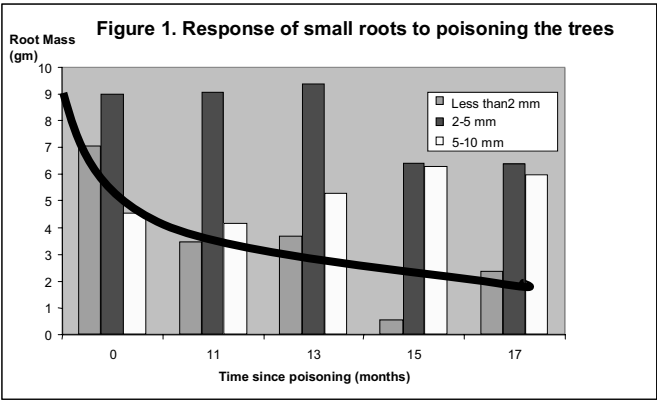
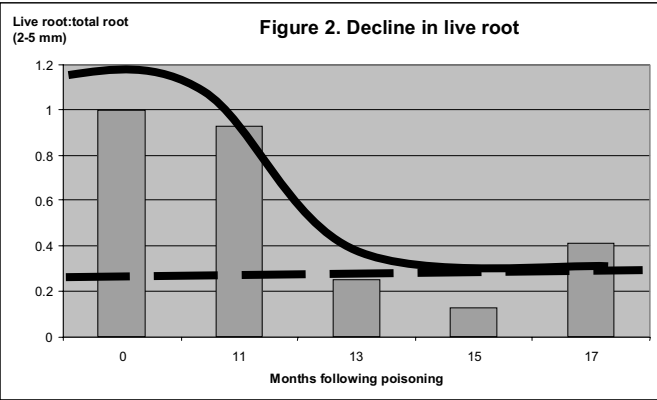


Figure 2 unravels the picture further by showing the proportion of roots 2-5 mm that are still alive. Assuming that the contribution of surrounding trees accounted for the live root in the samples at 13-17 months (dotted line), then the data suggest that the April timing for poisoning (11 months) is less effective in killing big poplar trees, confirming observations of the above-ground response.



What about roots thicker than 10 mm?

Roots more than 10 mm diameter contributed only 5% of the root length, so are very thinly dispersed around the tree.

When the fine roots die the water supply to the rest of the tree ceases. Cells lose water and die. The dead roots quickly dry out and become brittle, and lose their strength to resist any soil deformation. They do not bind soil particles in the way that fine roots do.

In summary:

- The roots of poisoned poplar trees deteriorated very quickly and lost any capacity to bind soil particles and stabilise slopes within a year.
- Within a year a poisoned tree functions like a bare slope, except within 2 m of the trunk where the bulk of large roots will provide some resistance to soil movement.

4 Risk Management

4.1 Safety issues

Some techniques that farmers used in past decades to prune their trees involved chainsaw use, and at that time safety standards, including the use of protective clothing and equipment, were not considered except for common sense. Accordingly, some ‘close calls’ occurred and such operators were lucky to survive. The ladders then available on farms were usually too short and unstable for tree pruning, and farmers would often use their chainsaw above head height, which is a most dangerous practice.

Any farmer considering pruning established trees should undertake appropriate training beforehand.

The farmer must minimise potential risks while pruning willow and poplar trees or harvesting them for supplementary fodder. As with any farming operation it is mostly a matter of using the right equipment properly.

Information on training courses in safe tree management procedures should be available through regional councils, forestry equipment suppliers, rural stores, or will be listed in the regional telephone directory under ‘Forestry Services’. The following websites are worth checking for training services, some being regional contacts only:

- Forestry Industry Training Organisation (FITEC), Auckland – www.training.org.nz
- National – www.agribusiness.ac.nz
- Northland – www.treeskills.co.nz
- Forestry, Bay of Plenty – www.waiaraki.ac.nz
- Wairarapa - www.taratahi-ag.ac.nz
- Marlborough – www.palms.co.nz

Others can be found through chainsaw sales outlets. For example, a Manawatu contact (Jackie Payne, tel (06) 329 7726 or jax@inspire.net.nz) organises free two-day farm safety courses that includes chainsaw use and tree work. Other forestry training contacts may be found by searching the New Zealand websites.

Create a 'pruning nest'

A tree pruner can create a much safer position during the work by forming a 'pruning nest' in each tree. This entails pollarding a willow or poplar tree (cutting its main trunk at 1.5-2.5 m above ground level at about five years age). A pruning nest then develops from the regrowth as a cup-shaped structure formed by multiple thinner branches, and this supports the operator with much greater safety.

When using this nest, the branches are there to help to prevent the operator from falling from the tree. It is still recommended that a forestry pruning harness is worn, because this helps to prevent a fall when the last branches are being harvested. Thinking the job through BEFORE making the cuts can improve the operator's safety.

Trees are dangerous!

When they are being cut willows can suddenly split vertically (known by contractors as 'barber's chair'), as this timber tends to 'shoot' when the chainsaw is partway through cutting. This can happen in an instant, and can easily knock the operator off their stance, or worse still, knock the moving chainsaw into the operator's body.

Every cut must be carefully considered, and anyone inexperienced in using chainsaws should certainly contemplate this task with great care before proceeding. Learn the approved way to cut off tree limbs (rather than your own) by undertaking some training. Approved methods are based on experience – including bad experiences!

4.2 Diseases

Poplar diseases

The most significant poplar diseases in New Zealand are caused by the poplar leaf rust fungus (*Melampsora larici-populina*) and the leaf spot or anthracnose fungus *Marssonina brunnea*. Both of these leaf diseases thrive in our cool, moist environments and cause early defoliation, reduced root and stem growth, and dieback in susceptible cultivars. *Melampsora medusae*, an American poplar rust, can also cause minor problems. Newer clones are selected for their resistance to these diseases.

Plant nursery catalogues identify the most successful tree types now available for use in particular regions.

Rust disease develops on trees during wet summers, and leaves show the characteristic rusty pustules and then drop. This foliage is unpalatable to livestock but the fallen leaves will add to the soil organic matter.

If the trees are successively defoliated they will weaken, but there is no practical control of rust other than by planting the more resistant types.

Poplar leaf rusts naturally mutate, and new rust strains or species may arrive in New Zealand at any time. Hence clones that are sold as rust-resistant may in the future show less resistance to mutated or new rust fungi.



Rust disease on poplar leaves

Willow diseases

Although there are many diseases affecting willows in New Zealand, the economic significance of disease is low. The most widespread and damaging willow pathogens are the leaf rusts caused by *Melampsora coleosporioides* and *M. epitea*.

Leaf rust attacks only certain tree willows and causes premature leaf defoliation that can seriously impair growth. *Salix babylonica* is the most seriously affected, while *S. matsudana* and the *S. matsudana* × *alba* hybrids are resistant. Some shrub willows (*S. cinerea*, *S.* × *caladendron* and *S.* × *reichardtii*) are also attacked by rust disease.

4.3 Pests

Possums

There can be numerous possums in areas where control measures are not undertaken. They cause serious damage to native plants, birds and agriculture, including:

- Eating eggs and nestlings of native birds.
- Damaging native forests, pine plantations, fruit, crops and gardens.
- Competing with native birds for fruit and nectar.
- Eating large amounts of pasture intended for farm animals.
- Spreading Tb (Bovine Tuberculosis) to cattle and deer.
- Eating poplar and willow foliage.

Funding is available to help landowner groups to control possums on their properties. Under certain conditions a regional council can reduce possum numbers to less than ten percent of the numbers before treatment. The regional councils usually contract out possum control operations to meet specific control needs. Farmers should consult the local land management officer responsible for animals. Outstanding results have been reported from possum control operations, especially for limiting bovine Tb spread to cattle and deer. Possum control also reduces damage to native wildlife, forestry, crops and poplars and willows for soil conservation and shelter/shade.

Poison safety All poisons used in bait stations are green or blue and are dangerous when eaten. For first aid be sure to read the manufacturer's instructions on the package. Further poison information, including safety procedures, will be provided at the time of purchase. If an animal or pet has possibly been poisoned, take them to the nearest veterinary clinic. Vitamin K1 is an effective antidote for anticoagulants but may need to be administered regularly for several weeks. Possum traps and poisons are a low risk for cats and dogs if they are used correctly – but be sure to **store poisons away from children and pets**.

Willow sawfly

First discovered in 1997 in Auckland, this pest is now spread throughout the country, except for the west coast of the South Island. All tree willows in New Zealand are prone to damage by larval feeding. Larvae only mature on willows, emerging from eggs laid on the leaf upper surface. They eat a hole

in the leaf and then feed along its edge. One larva can eventually eat several leaves.

Serious outbreaks of sawfly, with willow trees defoliated and some tree deaths have been recorded in Northland, Auckland, Waikato, Bay of Plenty, East Coast, Hawke's Bay, Wairarapa and Canterbury. Regular outbreaks have however only been recorded on the East Coast of the North Island.



Willow sawfly

Sawfly outbreaks occur most commonly in summer during settled, hot and calm weather. As trees are progressively defoliated they suffer from reduced growth. In severe outbreaks branches become brittle and die, and recovery of affected trees is a slow process.

HortResearch and Regional Councils researched this pest to understand its distribution and life cycle better, and how environmental effects can restrict its impact. HortResearch is looking at potential chemical and biocontrol methods against sawfly and is breeding resistant willow types, as well as determining the effect of mixing willows with alternative tree species for riverbank and soil erosion control.

New tree willow clones are currently being field tested for sawfly resistance/tolerance in Northland, Wairoa, Bay of Plenty, Gisborne, Hawke's Bay and Wairarapa. The willow breeders have crossed *Salix lasiandra* from California (where this sawfly is endemic) with *S. matsudana* x *alba* hybrids. These clones currently dominate soil conservation plantings on hill country and riverbanks.

No natural parasites or parasitoids of willow sawfly have been identified. Birds may exercise some control in heavily infested areas. Insecticides are effective against sawfly but their use is costly, and the expense is probably only justified in a browse block. Injecting mature trees with systemic insecticide has significantly reduced damage but this effect has not persisted into the next season.

The shrub 'Kinuyanagi' willow (also called the Japanese fodder willow) has shown consistent resistance to sawfly in many regions. It seems that the

adult is reluctant to lay eggs on this species. For further advice contact your local Regional Council.

Other pests

Other pests commonly damaging poplars and willows include wild deer, goats, rabbits, horses and hares. These may require specific methods to minimise their effects so check with the local land management officer on how to resolve the particular damage problem.

5 Cost-benefit analysis of tree fodder

From John Stantiall, Wilson & Keeling Ltd, Feilding

Analysing the financial benefits of using poplars and willows as fodder trees is a challenging exercise, due to the range of possible scenarios and different perceptions about which costs should be included.

The range of scenarios includes poplar trees – planted specifically for fodder or for erosion control – which are pollarded (branches cut back to a stump above browsing level) for drought feed; shrub willows which are grazed by sheep or cattle; and shrub willows used for dairy effluent management.



Items often discussed with respect to inclusion in the analysis are the initial establishment costs, loss of grazing during establishment and labour costs. The analysis to date suggests that trees managed for fodder only may be cost-effective in some situations if the labour cost is not taken into account.

Any particular analysis is only valid for the set of circumstances being studied and the assumptions made. For the purposes of this project, the farm systems where the trial blocks were grown were initially modelled because recorded information was available. Based on this information and a set of assumptions, several similar scenarios were developed to investigate the impact of variables, such as the percentage of effective farm area planted in trees. Ultimately, the model could be developed to the stage where farmers could input their own information and test the economic benefits of planting trees for fodder or dairy effluent disposal on their own farm.

The following results are tentative, and may be modified over time as new information becomes available or the method is refined.

5.1 Pollarded poplars

For a poplar block space-planted at 400 trees/ha, if the trees are harvested every three years, it is assumed that the pasture production is similar to a

block without trees because a reasonable proportion of light still filters through to the pasture. Based on 2004-05 prices, the cost of establishing a pollarded poplar block is about \$3,140/ha, or \$1,680 if labour costs are not included.

The model is based on the availability of edible dry matter, and assumptions made (based on farmer experience) about the difference in lambing percentages for the ewe flock and stock sale weights.

Farmer experience indicates that ewes fed tree fodder have an increased lambing percentage of 3-5% compared with the others in a drought situation. Hence for the whole flock, the impact on lambing percentage will depend on the proportion of ewes that have access to the tree fodder. This is illustrated by the following example:

Assumptions:

- A pollarded poplar system.
- Farm size of 600 ha.
- Flock size of 1750 ewes.
- Tree fodder comprises 15% of the ewe's diet.
- 120% lambing without any tree fodder.
- 126% lambing with tree fodder.

Area in trees (ha)	Percentage of farm	No. of ewes fed tree fodder	Average flock lambing percentage
1.25	0.2	179	120
5	0.8	716	122
10	1.7	1433	123

From this table, it can be seen that the impact of a small area of trees is diluted across the total flock. While the extra lambs provide extra income, this relativity only occurs in the drought years.

The stock performance advantage for fodder trees only occurs in the drought years (one year in five is used in the model). In the other four years, the farm with the trees has the same stock performance, but must continue to carry the extra costs.

The greater the area of trees, then the greater the costs that must be carried each year. Hence, in non-drought years, the farm operating surplus is decreased by the cost associated with having the trees. Based on current costs and prices, for a 600 ha Otago farm, up to 4 ha (0.7% of farm area) of pollarded poplars is profitable if the labour costs are not included. On a North Island hill country farm, however, where there is a higher sheep stocking rate, up to 2% of the farm area in pollarded poplars may be profitable if labour costs are not included.

5.2 Browse willows for sheep grazing

The willow browse block is planted at 7,000 trees/ha. Often, an area is chosen which is constantly waterlogged, and hence produces very little pasture, especially during winter. The willows have the effect of drying the soil, allowing more pasture to grow and be grazed throughout the year. Hence this system can result in extra pasture production along with the tree biomass, compared with similar areas without trees. On this basis, extra stock are wintered on the browse block. The willow block has a high establishment cost (\$9,870/ha including labour, \$7,320 without) due to the high plant population. There is also a loss of grazing during the establishment phase, but this is minimal due to the low initial pasture production.

For a 500 ha Wairarapa case study farm, up to 2 ha (0.4% of farm area) of browse willow was profitable if the labour costs were not counted. If the willow tree crop lasts only ten years, then the establishment costs double within a twenty-year period, and each crop provides fodder for only two droughts. On this basis alone, the crop would be unprofitable, however, the crop needs to be grazed each year, and as further information is gained, the net benefit of annual grazings needs to be reviewed.

5.3 Willows for dairy effluent uptake and forage

For the case study property at Clydevale, Otago, willow cuttings were planted at 7,200/ha on 0.6 ha and a 'K-Line' irrigation system was installed (new line only, the base infrastructure was already on the farm). The edible yield in February 2006 was about 0.35 kg DM/tree from the trees planted as cuttings. At about 90% tree survival (6,480 trees/ha), this equates to 2,268 kg DM/ha for the first 18 months. It has been projected that once

established, the annual growth of edible material will be about 1.8 kg DM/tree or 11,664 kg DM/ha.

For the specific case study at Clydevale, the model produces a net benefit of over \$372/ha of trees planted, or a benefit over the whole farm of over \$0.93/ha. For a given situation, the relativity between the tree area and the farm size will have a big influence on the overall net benefit to the farming business. Note that these figures are for the fodder value from the system and exclude benefits/costs of nutrient removal by the willows.

NB: Please note that these figures relate to the fodder value from the system and exclude benefits/costs from nutrient removal by the willows, or any other application of these trees on a farm.

6 Glossary of terminology

Browse block – an area densely planted with willow or poplar cuttings/stakes/wands at 7,000-12,000 stems/ha that is kept mainly for providing supplementary feed during dry summer periods, or used to relieve livestock (particularly sheep) from internal parasite burdens.

Clones – plants that have been selected and then only multiplied/propagated by vegetative means – usually taking cuttings in trees. Each plant or tree is genetically identical to all the other individuals of the same clone.

Coppicing – when poplars or willows are cut to near ground level regularly, with the foliage and stems removed and fed to livestock. In this publication this term applies to blocks grown for effluent management.

Epicorms – small shoots that develop off a tree trunk, which are particularly apparent growing where branches have been pruned. These should be removed at each pruning.

K-Line – a popular irrigation system involving a series of plastic spray nozzles, each protected by a semi-spherical dome with an open top. These nozzles are connected by alkathene pipe and the irrigation line can be towed to a new pasture area behind a quad farm bike and reconnected to the water supply.

Pollarding – a method of topping a tree at above stock grazing level (usually less than 1.8 m) to develop a bushy foliage multi-stem growth form. Pollarding is ideal for growing fine-branched tree fodder and is easier and usually safer for farmer tree-pruning operations.

Pruning nest – the cluster of fine branches that develops following pollarding, providing a safer position for a farmer to prune these branches for supplementary summer feed.

Ramicorns – vigorous branches that are steeply angled and which could develop into a secondary leader on young trees. These are likely sites for splitting in older trees.

7 Further information

Public libraries, regional councils, farmer field days and farming shows are a good source of information on poplar and willow tree management. Articles regularly feature in *The Tree Grower*, popular rural and lifestyle farming magazines, and sometimes in the farming pages of newspapers. Anyone keen to receive technical information about trees on farms in *The Tree Grower* can become a member of the New Zealand Farm Forestry Association (www.nzffa.org.nz).

Websites: These can supply a range of valuable information, particularly the Regional and District Council sites and those of the Crown Research Institutes including HortResearch, AgResearch and Landcare Research. The following regional and district council websites are a selection for seeking further information:

Environment Bay of Plenty – www.envbop.govt.nz; Environment Canterbury – www.ecan.govt.nz; Environment Southland – www.envirosouth.govt.nz; Environment Waikato – www.ew.govt.nz; Far North – www.fndc.govt.nz; Gisborne – www.gdc.govt.nz; Greater Wellington – www.gw.govt.nz; Hawke's Bay – www.hbrc.govt.nz; Manawatu-Rangitikei – www.horizons.govt.nz; Otago – www.orc.govt.nz; Taranaki – www.trc.govt.nz

Publications: Some excellent books are no longer available, though they may still exist in libraries, in second-hand bookshops or on farmers' bookshelves. These include the *Plant Materials Handbook for Soil Conservation* (edited by CWS van Kraayenoord and RL Hathaway) published in 1986; *Catchment Control in New Zealand* (by AL Poole) published in 1983; and *Hill Pasture Improvement* (by FET Suckling) published by DSIR/Newton King in 1966.

Still available:

Using Trees on Farms edited by JFL Charlton and published by the NZ Grassland Association October 2003. (\$20 from www.grassland.org.nz).

Trees for the New Zealand Countryside by John and Bunny Mortimer. Publ. Taitua Books, RD 9, Hamilton. 1984. (available from Touchwood Books at www.touchwoodbooks.co.nz).

Key to Cover Photographs

			Growing Poplar and Willow Trees on Farms
Large trees can cause damage	Pollarding for fodder		Well-managed willows on a Central Hawke's Bay farm
Pollarded poplars in North Otago	Pruning from a pruning nest	Cattle enjoy willow prunings	
			Compiled and Prepared by the National Poplar and Willow Users Group

Photographs and drawings by Deric Charlton

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Guidelines to help landowners grow and manage poplar and willow trees on their land



Millions of poplar and willow trees are growing on farms for stabilising erosion-prone hill country, providing farm livestock with shelter and shade, resolving drainage problems and providing a source of supplementary fodder during dry summers.

This booklet contains information from practical experiences to give “best practice” protocols for establishing and managing poplar and willow trees and using them wisely.