The **Long-stem Planting** Guide

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Design by Marjo Patari, Gosford City Council.
Photos on front cover: long-stem planting along Ettalong Creek, long-stem planting, long-stem root ball, long-stem seedling about to be planted. Back cover: coastal area, Patonga Beach; riparian area, Umina; saline area, Yarrawa; rainforest area, Katandra Reserve, Holgate.
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Development of the long-stem planting method in Australia has seen an increase in the survival rates of seedlings planted in many different environments. The advantages of this method, such as no post-planting watering, increased growth rates and higher survival rates, have made a positive contribution to many rehabilitation projects and seen individuals and groups obtain successful outcomes in areas that were considered a challenge.

Within Katandra Reserve (Holgate, NSW) the long-stem planting method has been trialled on rainforest species, resulting in significantly greater growth rates in seedlings of some species planted using the technique (Chalmers *et al*. 2007). Furthermore, native riparian species planted using this method in the Hunter Valley (NSW) showed greater survival rates (20-50 per cent better, depending on the species) compared with standard planting methods on river banks and demonstrated that native plants could indeed be reintroduced on to river banks where previous efforts had been unsuccessful (Hicks *et al*. 1999). Within saline environments survival and growth rates of long-stem planting has been exceptional (Hicks 2003) and, recently, the long-stem planting method has been used in a sand dune environment with great success for both survival and growth rates (Bakewell *et al*. 2009).

What is long-stem planting ?

The long-stem planting method is an innovative way of planting that can result in higher survival and growth rates with minimal post-planting care. Using the long-stem method, seedlings are grown in pots for 10-18 months, so that they develop long woody stems. These seedlings are then planted with about three-quarters of their length below the soil surface, approximately 1 metre deep, which results in much of the woody stem being covered with soil.

The deep planting protects the roots from substantial changes in soil temperature, allows the plant access to deeper soil moisture and reduces competition from weeds. Once planted, the seedling develops roots from the buried stem and leaf nodes. This promotes the development of a robust root network which gives the seedling a greater chance of survival.

The long-stem planting method has challenged two long-held horticultural principles:

1. Large plants should not be grown in small containers as they will become root bound, thereby hindering the future growth of the plant.

The long-stem method uses plants that are relatively tall for the size of the pot they are grown in. This is achieved through the use of standard pots. In addition, slow-release fertilisers are placed in the centre of the pot so that the plant does not need to grow extended roots in search of further nutrients. This prevents the plant from becoming root bound in the pot and allows for the development of healthy roots when planted in the ground.

2. Stems of seedlings should not be planted below the surface of the soil as this subjects them to fungal attack and disease.

The long-stem planting method appears to challenge this long-held horticultural belief since most of the seedling's woody stem is planted underground, yet survival rates of these seedlings have been higher than that of those planted using traditional methods. While this has been observed during both scientific and field trials, further research is needed to determine why the stems of long-stem plants are not prone to disease and fungal attack.

Field trials using the long-stem method have included a variety of native species to demonstrate that seedlings can not only be grown successfully when these two traditional principles are not followed, but can have survival and growth rates that exceed those planted using traditional planting methods. It would appear that most, if not all, hard tissue plants are suitable for use in long-stem planting (Hicks 2010, pers. com.,nd).

Gmelina leichhardtii

How the long-stem method was developed

The long-stem planting method was pioneered by Bill Hicks for use on river banks in the Hunter Valley. Bill wanted to establish native species on river banks instead of willows (*Salix* spp) as was the recommended practice at the time. The spread of willows had become an environmental problem, impacting on the ecology of river systems and wetlands in much of temperate Australia. Willows affect the flow of water and reduce biodiversity. Willow species are now listed by the Australian Government as Weeds of National Significance (1998), and are no longer recommended for planting.

The riparian environment presents challenges for the planting of natives using traditional planting methods as the seedlings are continuously affected by changes in water levels, river flow, and processes of erosion and sedimentation. Once the long-stem planting method had been developed and tested, Bill conducted workshops throughout New South Wales, Victoria and South Australia to educate communities about the use of the method and its value in revegetating cleared, disturbed and hostile natural areas. Individuals and groups have since conducted scientific field experiments to examine the effectiveness of the method in a range of habitats, including rainforest, sand dunes and saline sites. The Australian Plants Society Central Coast Group have used the method for a number of years at their Bushcare site in Katandra Reserve. With assistance from Bill Hicks the method was altered slightly to suit:

- the local rainforest conditions at Katandra;
- the number of plants required each year; and
- the tools and materials available to the Bushcare group.

The long-stem method has now been used throughout Australia and overseas, including revegetation projects in New Mexico.

Clockwise from top left: Equipment and seedlings ready for planting, long-stem seedlings ready for planting with bottles of water, materials needed for potting.

Step-by-step guide to long-stem planting

The long-stem planting technique contains a number of steps which are considered to be important to the overall success of the method. However, once you have tried the technique you may be able to make changes in order to suit your site's particular needs.

Tools and materials suggested/required for plantings are:

- **seedlings or seeds** for revegetation projects, local provenance seeds or seedlings are recommended as they will provide a range of ecological benefits including providing habitat for local fauna, and maintaining local genetic integrity.
- **pots** use standard 50 mm square-cornered pots.
- **potting mix** use a good quality mix for natives. Large pieces can be sieved from the mix and used at the bottom of the pot to stop the mix from escaping.
- **trace elements** for native plants (e.g. Micromax^{R}).
- **slow-release fertilisers** suitable for native plants. Two types are required: a 5-6 month slow-release fertiliser; and an 8-9 month slow-release fertiliser.
- **potting racks** to hold the pots off the ground or bench while the seedlings are growing in your 'nursery'.
- **seaweed solution** use half-strength seaweed solution in a bucket of water to fully immerse the potted seedlings. This is recommended just before planting.
- **tools for planting** shovel, post hole digger or auger, or water lance.
- **water for planting** if a water supply is not available and the water needs to be carried to the site, the use of as little as 2 litres per plant has been successful, but more can be used if the sub-soil is dry.

Top left and right: half-fill pot and create a depression/hole for the fertiliser and seedling.

Centre left: place the fertilisers in the hole.

Centre right: select seedling.

Bottom: place potted seedling in rack.

How to grow the long-stem seedlings

1. Use seedlings that have been grown in seed-raising trays using conventional methods, or collect the seedlings from a suitable location. Within Katandra Reserve, for example, small seedlings were collected from pathways and fallen logs in the rainforest, where there was little chance the seedlings would survive to become adult trees. Collecting seedlings from the natural environment ensures that you have the strongest seedlings which have survived where others have died. These stronger seedlings transplant more successfully. Collecting seedlings from the natural environment also allows you to choose from a greater variety of species which may be representative of all layers of the forest canopy. Conditions apply to the collection of plant material in reserves and national parks. Please check with your local authorities prior to collecting seeds or seedlings.
2. Thoroughly mix the trace elements through the potting mix (5 ml of trace elements per 7.5 litres of potting mix).
3. Half fill the pots with the prepared potting mix, placing the larger sieved pieces at the bottom.
4. Create a depression deep enough to hold the slow-release fertiliser. This depression can be made with a pen or stick with a diameter of approximately 1.5 cm. Place the fertilisers in the well (half a teaspoon of 8-9 month slow-release fertiliser, then quarter of a teaspoon of 5-6 month slow-release fertiliser). Gently place the seedling in the pot, taking care not to damage the fine hair roots. Carefully fill with potting mix and tap the bottom of the pot to settle the potting mix and improve contact between the potting mix and the roots. Top up the rest of the pot with potting mix. Water the seedling thoroughly and add more potting mix if necessary.
5. Place the pots on 'potting racks' so that they do not have direct contact with the ground or table. The potting racks provide a space between the bottom of the pots and the ground/table that result in the roots being 'air pruned'. This means that when the roots reach the outside of the pot they dry off (aerial pruning) and stop growing. This allows the roots to spread out into the surrounding soil and form a strong network when the seedling is planted.

Top left: dig hole with auger.

Top right: pour 1 litre of water into the hole and allow to drain before placing the seedling.

Centre: gently backfill the hole using water to settle the soil and eliminate air pockets. Then build up dish-shaped depression.

Bottom: add remaining water.

6. Select a suitable place for the seedlings to grow in your nursery. Choose the location to suit the species you are growing. Generally a sunlit position is recommended to encourage strong stem and leaf growth.
7. Water seedlings regularly and rotate the pots periodically to ensure all plants get an equal amount of water and sunlight.
8. Seedlings can take between 10 and 18 months to reach a suitable height for long stem planting. Seedlings should reach 1 metre during this time, however this would depend on the plant species' natural growth habit.
9. Soak the seedlings (still in their pots) the night before planting in a half-strength seaweed solution to ensure the root ball is thoroughly wet. This saturates the potting mix and assists in stimulating root development once planted.

How to plant using the long-stem method

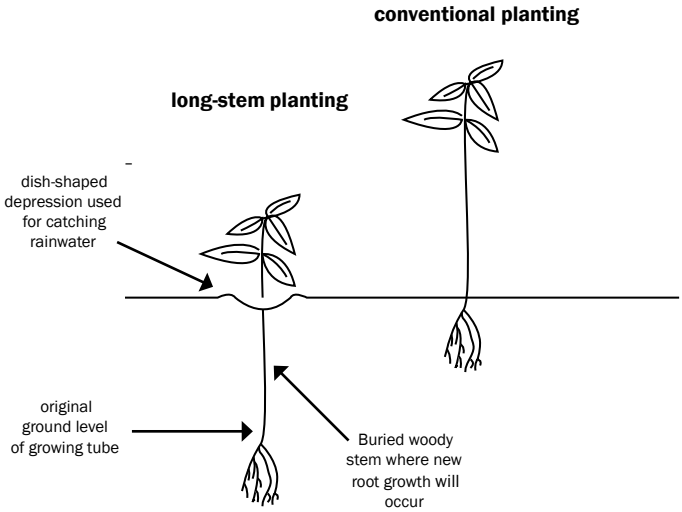
1. Dig holes that are deep enough to allow three-quarters of the plant to be buried. The use of power tools such as a soil auger in heavy clay may result in smooth walls in the hole, these may need to be roughened slightly to allow the roots to penetrate the smooth walls more easily.
2. Pour approximately 1 litre of water into the hole and allow it to soak in.
3. Prune side branches or large leaves from the lower portion of the stem that impede placement of the seedling in the hole when planting.
4. Place the plant in the hole and backfill carefully using soil and water alternately to ensure that no air pockets are left. This is important to prevent the roots from drying out.
5. Create a dish-shaped depression around the stem of the plant and add the remaining water. The depression will assist in catching any rain.
6. Generally no further maintenance is required. Since the root ball will be below the root zone of most weeds, competition from weed roots will be minimal. In moist environments, vine growth may need to be controlled.

Clockwise from top left: long-stem seedling before planting, close-up of roots developed from buried part of stem with a white line marking ground level, demonstration of original ground level and growth of roots from buried stem.

The original Bill Hicks method of long-stem planting differs slightly from the step-by-step method described above as he had a supply of water at his planting sites. The original method sourced water from the nearby stream using a water pump and then a water lance was used to dig the hole and thoroughly wet the soil. In soils prone to collapse, such as sand, a tube was used to support the hole around the lance. The plant was then placed into the tube and the plastic tube carefully removed. Water from the stream was used to water the seedlings in.

This original method of long-stem planting came out of a need to plant the seedling deep enough into the river bank so they would not be washed out during flooding in the riparian environment. While doing this Bill realised that the survival and growth rates were enhanced.

Bill grew plants from seed he collected from local sources. Shortly after germination seedlings were planted out into separate pots using the long-stem method and grown for the 10-18 month term as described above.



Above: Jessica planting a seedling at Katandra Reserve, Holgate, in 2004.

Below: Jessica next to the same plant to her left in 2009. Notice the general regeneration of the site due to long-stem planting.

General benefits

The benefits of the long-stem planting method are significant and include advantages which are of great assistance to bush regenerators and others interested in plant survival.

Firstly, the long-stem method creates an older, stronger seedling for planting. This is due to the consistent nutrients, air pruning and longer nursery period. If the seedling is also sourced from the natural environment through collection it has the added advantage of having survived the natural culling process of its local environment. This produces a much stronger plant than an ordinary seedling and increases its survival rate.

Another notable benefit is that the deeply-planted root ball is insulated from the substantial changes in soil temperature and moisture compared with traditional plantings where the plant roots are close to the soil surface.

In drier and saline environments, planting more deeply allows the root ball to be further away from the hot, dry or damaging salt-encrusted topsoils which increases the seedling's chances of survival.

Newly planted long-stem seedlings are also more stable in the ground than those planted using traditional methods. Deeper planting means that seedlings are better able to withstand soil erosion due to wind such as on sand dunes, or the effects of moving water such as flood conditions in riparian zones. The development of a deep root system allows the plant to bind greater amounts of soil, which is also why these plants are so stable in the ground.

Another benefit is the relatively small quantities of water required when planting, and that no further watering is required post-planting. This benefit is important on sites with limited water.

An unexpected benefit of long-stem planting has been the reduced loss from vandalism as it is more difficult to pull up a deeply-planted root ball (Hicks 2010, pers. com.,nd) and seedlings can survive trampling by people walking through planted areas (Bakewell et al. 2009).

Above: A long stem seedling two months after planting, along a creek bank at Umina Beach.

Below: the same seedlings three years later.

Finally, competition with shallow-rooted weeds is less likely to occur when seedlings are planted using the long stem method. The deeply-planted root ball accesses nutrients and soil moisture that is beyond the reach of shallow-rooted weed species. Given the reduced level of competition with shallow-rooted species, and that no follow-up watering is required, the after-planting care is minimised.

Riparian environment

As part of the original trials in the Hunter Valley, Bill Hicks grew seedlings to a height of up to 1.5 m and then planted 70-90 per cent of the plant below the soil surface. These trials revealed that three of the four species used exhibited greater growth rates using the long stem method. Bill showed that native plants could be reintroduced into riparian environments using the long-stem planting method where previous plantings trials had not been effective.

One of the main benefits of using the long-stem method within the riparian context is that the roots of seedlings are planted more deeply into the river bank therefore, the seedling is not washed away during a flood event. Long-stem planting also allows the root ball to be protected from extremes of temperature, including frosts and drying out that can damage plants which are planted using traditional methods.

Additionally, the restoration of riparian areas with native plants results in environmental benefits that cannot be achieved with exotic species. These benefits should not be overlooked. The use of native plants improves local biodiversity and does not impact negatively on the health of river systems.

Melaleuca quinquenervia.

Top: Newly planted White Beech (*Gmelina leichhardtii*) long-stem seedling.

Below: Katandra Reserve, Holgate, where long-stem planting has been trialled.

Rainforest environment

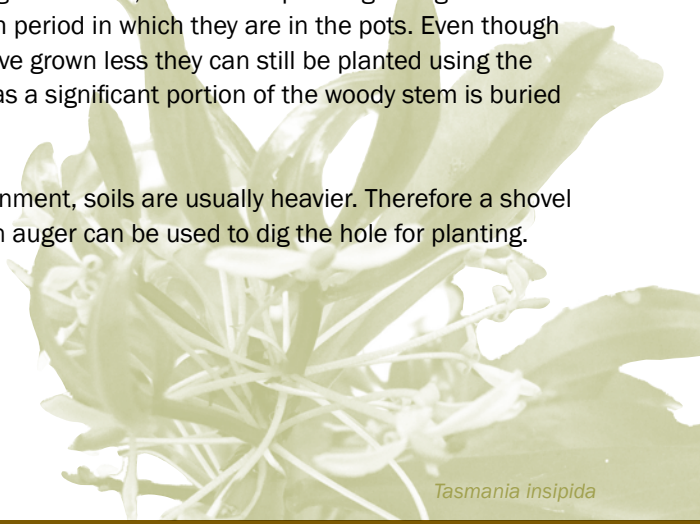
Research conducted in the rainforest at Katandra Reserve has indicated that some species show significantly greater growth rates when planted as long-stem seedlings (Chalmers et al. 2007). During these trials it was found that the growth of Cheese Tree, *Glochidion ferdinandi*, was significantly greater when planted using the long-stem method as opposed to traditional planting, while for Scentless Rosewood, *Synoum glandulosum*, the growth rate remained the same.

These trials at Katandra Reserve from 2002 to 2009 were conducted during an extended dry period. It is not known how long-stem planting would perform during a period of prolonged wet conditions. Field trials using a larger number of rainforest species are currently being undertaken to further study long-stem planting within rainforest environments.

Due to the great height of rainforest trees and the short seed 'shelf life' of many rainforest species it is often easier to collect seedlings from the forest floor in this environment. Collection of seedlings also provides benefits such as greater species selection and the harvesting of stronger individuals which have survived the germination process in forest conditions.

Rainforest species that are grown using the long-stem method show pronounced differences in growth habit, with some species growing to less than 1 metre in the 18-24 month period in which they are in the pots. Even though these species appear to have grown less they can still be planted using the long stem method as long as a significant portion of the woody stem is buried at planting.

Within the rainforest environment, soils are usually heavier. Therefore a shovel or a manual or petrol-driven auger can be used to dig the hole for planting.



Tasmania insipida

Top: Acacia long-stem seedling planted in a sand dune at Patonga Beach.

Below: Establishment of long-stem seedlings in the sand dune at Patonga Beach.

Coastal environment

It has been shown that in coastal areas long-stem planting of native sand dune plant species has been successful without the need for protective planting sleeves or follow-up watering. Seedlings planted in dune areas using the long-stem method experienced greater survival and growth rates than tube stock planted using the traditional planting method.

At Patonga Beach (Central Coast, NSW) the long-stem planting method has been used in trials of Coastal Wattle, *Acacia longifolia* var. *sophorae*, to restore the beach dune area. Results of these trials concluded that the long-stem method produced higher survival rates compared with plants using a traditional planting method (79 per cent compared with 53 per cent). Greater growth was also recorded in the long stem seedlings (19 cm mean stem growth as compared to 8 cm for the traditional method) (Bakewell et al. 2009). Also, long-stem seedlings survived trampling and breaking of stems and shoots due to human impact in the planted areas.

Long-stem plants in sand dunes benefit from having reliable soil moisture, limited root competition, and stable soil temperatures. The likelihood of the root ball being exposed in dunes as a result of sand movement is reduced when the long-stem planting method is used.

The advantages of using the long-stem planting method in this environment include the elimination of the need to build structures around the seedlings to protect them and the need for post-planting irrigation. This can significantly reduce the costs associated with regeneration work and the amount of follow-up maintenance required at the site.

In sandy environments, digging deep holes can usually be done with shovels or other hand tools.

Spinifex sp.

Top: Two and a half year old long stem seedlings planted in a high saline area near Muswellbrook (Yarrawa) continue to show significant growth.

Below: Long stem plantings in the saline environment.

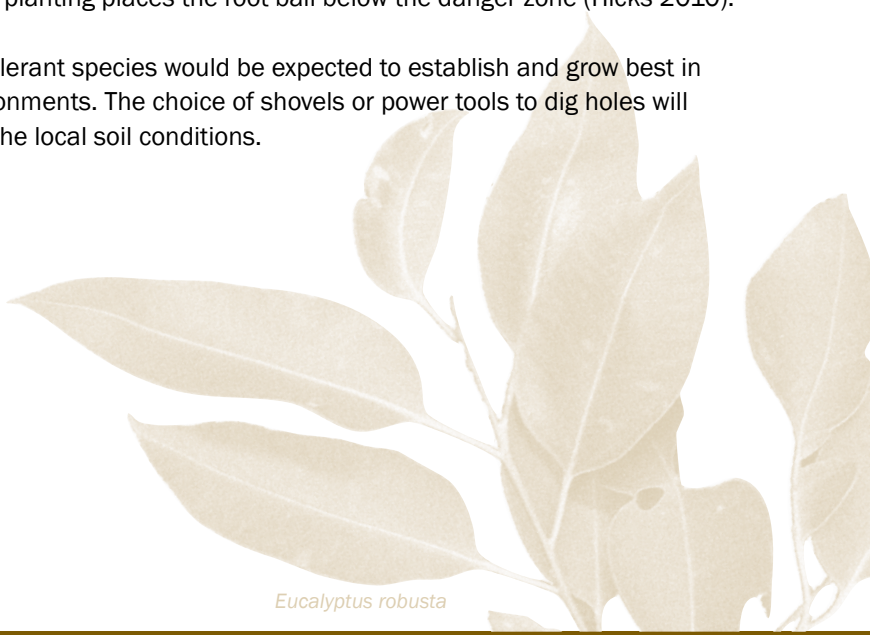
Saline environment

There has been great success in the use of long-stem planting within saline environments. After conducting trials within salt-affected lands in the Upper Hunter, Bill Hicks concluded that survival and growth rates of long-stem plantings had been outstanding (Hicks 2003). During these trials Bill planted 2,500 salt-tolerant seedlings. The trees survived a record drought, above-average temperatures and frosts as well as high salinity levels (Hicks 2003). It appears from these trials that virtually any native salt-tolerant species is suitable for long-stem planting.

The Hunter-Central Rivers Catchment Management Authority at Muswellbrook, NSW, has also used long stem planting at their saline site. Fresh water was used to water the seedlings in. At this site it was found that long-stem planting worked better on drier saline sites than wet saline ones and further research is needed to understand why.

The main benefit of this method in a saline environment is that the root system is planted below the salt-encrusted top layer of the soil. Soil salinity suppresses plant growth and creates a hot, dry and uninhabitable environment. As in other areas, deep planting places the root ball below the danger zone (Hicks 2010).

Local salt-tolerant species would be expected to establish and grow best in saline environments. The choice of shovels or power tools to dig holes will depend on the local soil conditions.



Eucalyptus robusta

Resources required

The actual cost and resource requirements for long-stem planting in comparison with traditional methods will vary between projects and site locations. The level of maintenance will be influenced by the environment being planted. The following table lists the resources that need to be considered when making comparisons between the two methods.

While long stem seedlings are kept for a longer time in the nursery, the advantages of reduced pre-planting site preparation, reduced cost of plant protection, reduced need for post-planting weed control and improved survival and growth rates are considered to be significant.

Resource	Long-stem method	Traditional method
Site preparation including soil preparation and ground cover weed control	Not usually needed. May be required for large plantings	Weed control and ripping may be required
Plant sleeves or other materials to protect against wind and frost	Not usually needed. Can be useful to protect from browsing animals	Required in some locations
Post-planting maintenance such as watering, weed control, fertilising, and mulching	Not usually needed	Weed control and watering usually required
Use of power tools/ equipment to dig holes	May be required in some environments	Usually not required for small scale projects, but may be used for larger projects to save time
Length of time to dig holes	Usually longer for long stem planting	Usually shorter for traditional method
Length of time that potted seedlings require fertiliser	Only initial slow-release fertiliser required. None required post-potting	3-6 months after potting
Length of time that potted seedlings require watering	10-18 months	3-6 months after potting
Length of time seedlings are in the nursery	10-18 months	6-12 months after potting

Conclusion

The use of the long-stem planting method provides an opportunity to improve the survival rate of native plants in the restoration of degraded ecosystems. Long-stem planting has shown to be successful in a wide range of environments and conditions.

The long-stem planting method has been shown to be a particularly successful method to use in environments where the surface soil conditions are not generally favourable for planting. This may be due to low moisture levels, high temperatures, high salinity, or surface ground movement due to flooding or human activities such as walking. In these cases the long-stem planting method offers the advantage of planting the seedling more deeply into the ground and away from these adverse effects. It is unclear whether the method provides the same advantages in environments where subsoil moisture conditions are unfavourable during drought.

We encourage others to trial the method at their work sites and would welcome feedback on the results.

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For further information

Australian Plants Society Central Coast Group: www.australianplants.org/longstem.htm
Hunter-Central Rivers Catchment Management Authority: www.hcr.cma.nsw.gov.au
Bill Hicks Longstem Tubestock DVD: www.norkhiltechnologies.com
NSW Environmental Trust: www.environment.nsw.gov.au