

The use of Native Long-stem Tubestock as an Alternative to Willows for Controlling Streambank Erosion

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SUMMARY: Historically, the success of river training works in NSW has relied almost exclusively on the use of willows (*Salix* spp.) as the main method of vegetation establishment. The ecological and geomorphological problems associated with the widespread use of willows have become apparent during the last decade (see various papers in this volume).

Unfortunately, streambank revegetation projects in the Hunter Valley using alternatives to willows, such as standard native tubestock, have experienced significant failures. These failures occurred as a result of the inability of standard native tubestock to survive scouring and sediment burial associated with floods. High losses of standard tubestock planted in more elevated areas resulted in losses due to drought and weed competition. Deep planting of willow cuttings by contrast allowed them to survive and rapidly recover from flooding.

Trials are currently underway in the Hunter Valley of New South Wales using "long-stem" native tubestock as a viable alternative to the use of willows in streambank erosion control. The concept of long-stem tubestock was developed by Norkil Technologies Pty Ltd, following the recognition of the need for an alternative to willows. Long-stems are native plants that are grown using a specific potting media, nutrient regime and growth phase to produce a plant that has a thick, woody, elongated stem (to 2 metres), is climate hardened and has numerous nodes along the stem. Tubestock is usually planted at up to 18-months-old in the same method as willows using a water lancing jet. The root ball is buried some 0.5 to 1.5 metres below the surface and the hole is filled in around the plant stem. A percussion jet and sleeve have also been developed to allow planting in coarser material such as gravel and cobbles.

Trials have been established along the Hunter and Williams Rivers and Dingo Creek. Results to date suggest that for some species, the advantages of long-stem tubestock over standard tubestock include higher survival and growth rates, root development to a depth of up to 1.5 metres along the buried stem, the ability of plants to obtain sub-surface moisture, plants that are less liable to weed competition, and the production of hardier and more mature plants that are less prone to removal by scouring (due to planting depth).

THE MAIN POINTS OF THIS PAPER

- Native long-stem tubestock are a potentially viable alternative to the use of willows for streambank restoration.
- Long stem tubestock can have higher survival and growth rates than standard tubestock.
- Long-stem tubestock can be established at depth allowing access to sub-surface moisture, less competition from the roots of weeds, and quicker erosion control potential.
- Long-stem tubestock require little follow-up care or maintenance compared to standard tubestock.

1. INTRODUCTION

Historically, the success of river training and other erosion control works has relied almost exclusively on the use of willows (*Salix* spp.) as the main method of vegetation establishment (Raine and Gardiner, 1995). Willows were chosen due to their ease of establishment, rapid growth rates, fibrous root system, and the lack of maintenance required following planting. The success of willows for bank stabilisation stems from the fact that mature 2 to 3 metre long poles could be planted directly on site using a water lancing jet, at a depth of up to 1.5 metres. The planting depth allowed the plants to access sub-surface moisture,

avoid competition from weed roots, rapidly stabilise soil, and most importantly, have the ability to survive the impacts of floods. The fact that mature willow poles (5 to 10cm in diameter) were used allowed plants to establish relatively quickly and produce rapid growth rates, and therefore provide quick and effective erosion control.

The ecological and geomorphological problems associated with the widespread use of willows has become apparent during the last decade (Ladson et al. 1997). In particular, regeneration by seed has

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led to a proliferation of willows along many streams in eastern Australia with the potential to cause major changes to stream geomorphology. Such concerns have led to the recent declaration of the majority of willow species as noxious weeds within New South Wales.

Until recently, there was no comparable native alternative to the use of willows for streambank erosion control. In many cases, to be successful, the use of standard native tubestock required follow-up weeding and watering. Even then, plants required several years to establish before they performed an erosion control function. In harsh, highly-altered environments such as those along the Hunter River on the central coast of New South Wales, survival rates of standard native tubestock were very low (Vernon, 1987).

In a collaborative project between Norkhil Technologies Pty Ltd (NT), NSW Department of Land and Water Conservation (DLWC), Hunter Catchment Management Trust (HCMT), with supporting funding from the Natural Heritage Trust, trials are currently underway in the Hunter Region using “long-stem” native tubestock as a viable alternative to willows. It is the aim of this paper to provide the successful results of these trials, and describe the growing and planting techniques for long-stem tubestock.

2. WHAT ARE LONG-STEM TUBESTOCK?

The concept of long-stem tubestock was developed by Norkil Technologies Pty Ltd, following the recognition of the need for an alternative to willows. Long-stem tubestock are native plants grown for 12 to 18 months and fed using a specific nutrient control program until a plant with an elongated stem of up to 1.5 metres long is produced. These are then planted at depth in a similar fashion to willow cuttings.

2.1 Growing Long-stem Tubestock

Most standard plant growing media consists of a combination of organic and inorganic (usually sand) constituents. Long-stem tubestock are grown in a media consisting entirely of organic material. The organic mix should preferably be composed of horticultural grade pine bark and pine bark fines and composted for at least 7 months to minimise nitrogen draw-down. This mix allows greater moisture retention (sand is usually included in most mixes for drainage and to provide bulk) and maximum available area for plant root development.

Plants are grown in standard, open-based tubes placed on an elevated wire-mesh bench. The bench allows any

roots which protrude from the bottom of the tube to be naturally pruned as they come into contact with the air. The result is a root system consisting of numerous vertical roots and a procedure that prevents root curl from occurring.

Plants are subject to a nutrient regime consisting of slow release fertiliser (low phosphorous content) supplemented with slow release micro-nutrients, both designed to release over an 8 to 9 month period. The fertiliser is of low phosphorous content. Plants are provided with an initial infusion of slow release mini-fertiliser to boost growth over the first 4 months, ahead of the 8-9 month fertiliser.

Micro-nutrients in the form of Micro-max Trace-element compound is also added to the growing mix at the time of preparing the organic mix.

It usually takes 12 to 18 months to produce a long-stem plant, depending on the species and growing conditions. Plants should be grown in “hard” conditions to ensure an upright plant with numerous nodes and a small inter-nodal space. Stem elongation should not be encouraged by limiting light availability, as this will result in plants with thin, weak stems, and a large inter-nodal space. A high density of nodes is important, as it is from the nodes that roots will sprout once the long-stem tubestock is planted.

2.2 Planting Long-stem Tubestock

Long-stem tubestock are planted in a similar fashion to willows using a water lancing jet attached to a small, high pressure, pump. Two types of jets have been developed. These are:

- standard jet for planting in fine soils, sands, and loams (Figure 1); and
- percussion jet for planting in gravel and cobbles (Figure 2).

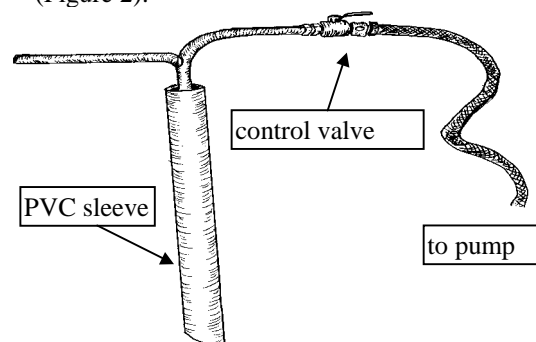


Figure 1: Illustration of standard water lancing jet, constructed of 3/4 inch galvanised steel (developed by DLWC).

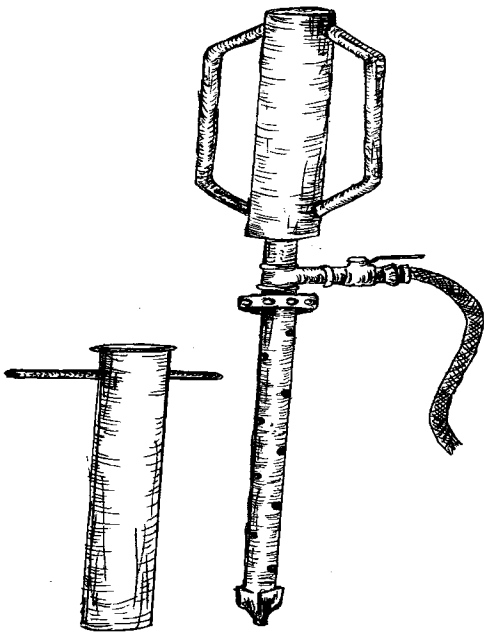


Figure 2: Illustration of percussion jet (developed by Brian Bertrum of Bobin Landcare Group and David Russel, DLWC). The sleeve is a metal cylinder with a handle to allow removal. The jet has a reinforced pointed tip to allow it to penetrate the stream bed, and holes to allow the water to escape.

Planting of long-stem tubestock is a four-step process. This process is illustrated in Figure 3a - 3d using a standard water lancing jet.

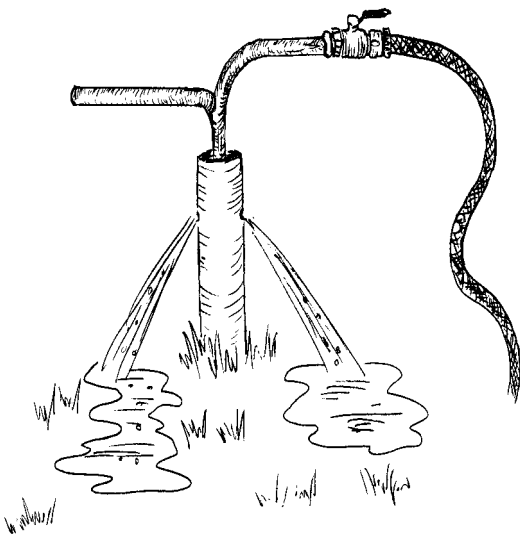


Figure 3a: Step 1 - The jet is placed inside a PVC pipe and the pressure of the water used to drill a hole in the soil to a depth of 0.6 to 1 metre. Holes in the top of pipe allow water to escape. It should be noted that the PVC pipe is not necessary in cohesive soils such as silts and clay-loams.



Figure 3b: Step 2 - The jet is removed from the pipe and the long-stem plant (remove tube) is placed in the PVC pipe. If necessary a stick or rod is used to push the plant to the base of the planting hole. In most cases, 70-90% of the plant length is placed in the hole. In cohesive soils the plant is gently placed directly into the hole.

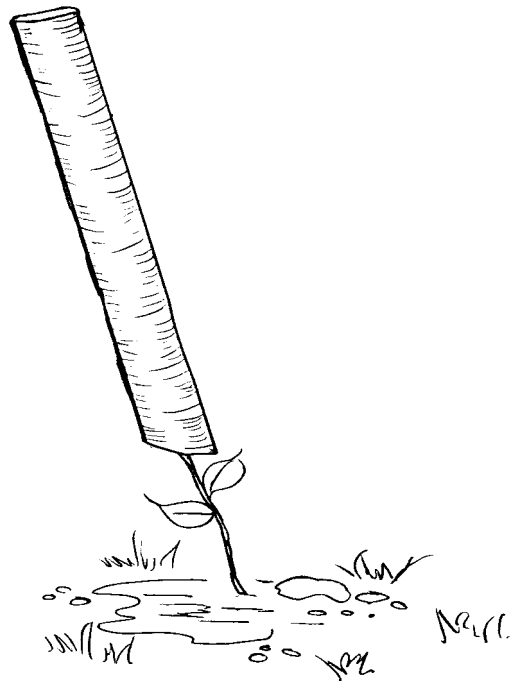


Figure 3c: The PVC pipe is removed from the hole, leaving only the long-stem tube. Care must be taken to ensure that the plant stays in the hole while the pipe is removed.



Figure 3d: The hole is filled in around the plant. It is important to ensure that the entire hole is filled with soil. Air pockets will retard growth and discourage root development from the nodes.

Planting in gravel or cobbles using the percussion jet is carried out in a similar fashion to the steps above. The PVC pipe is replaced by a steel pipe with drainage holes and a dolly bar is used to hammer the jet to the required planting depth.

3. TRIALS OF LONG-STEM TUBESTOCK

3.1 Trial Methods

Trials comparing growth and survival rates between long-stem tubestock and standard tubestock were established at Luskintyre on the Hunter River, Seaham Weir on the Williams River, and Marlee on Dingo Creek. The site at Luskintyre was later abandoned as a trial due to poor planting method (the planting holes were insufficiently backfilled, resulting in high losses).

The trial on the Williams River commenced in November 1997, and involved the planting of *Callistemon viminalis* (weeping bottlebrush), *Tristaniopsis laurina* (water gum), *Waterhousea floribunda* (weeping myrtle), and *Casuarina cunninghamiana* (river oak).

Plots were established using a block grid pattern, with the same species planted 1.5 metres apart in each row. Rows of species were planted parallel to the water's edge alternating between 10 long-stem plants, 10 standard tubestock, 10 long-stem plants, and so on, with 50 long-stem and 30 standard plants for each species. Row order, with increasing distance from the water's edge consisted of *C. viminalis* (water's edge), *T. laurina* (bank slope), *W. floribunda* (bank slope), and *C. cunninghamiana* (bank top). Each row was

spaced 0.5 metres apart and each plant was offset 0.5 metres from the species in the previous row.

The trials were undertaken on a gently sloping bank comprised of alluvial silty loams. The bank was already heavily grassed with kikuyu, and stock were excluded. Long-stem plants were jetted in to a depth of approximately 60cm using the standard jet. Standard tubestock were planted to a depth level with the top of the tube. Parameters recorded were rainfall, plant growth rates, and survival rates.

The trial at Dingo Creek commenced in March 1998 and involved the planting of *C. viminalis*, *C. cunninghamiana*, *Ficus coronata* (creek sandpaper fig) and *T. laurina*.

The trial was established using the same planting layout as the Williams River site, with the difference that rather than alternating between 10 long-stem than 10 standard tubestock of the same species in each row, 30 long-stem were planted, followed by 20 standard tubestock of the same species in each row.

Row order, with increasing distance from the water's edge consisted of *C. viminalis*, *C. cunninghamiana*, *F. coronata*, and *T. laurina*.

The trials were undertaken on a bar consisting of gravel to cobble sized material. The bar was relatively weed-free and contained some scattered saplings of *C. cunninghamiana*.

Parameters measured were the same as the Williams River site.

Other plantings have also been undertaken across the Hunter Region as part of riparian revegetation programs. Although no specific data has been recorded at these sites, a diverse range of species have been used and valuable information obtained on the ability of species to be planted as long-stem tubestock.

3.2 Trial Results

3.2.1 Growth Rates

A comparison of growth rates between standard tubestock and long-stem tubestock was undertaken at each site by comparing the height at planting to the present height. This provided data for approximately 11 months and 6 months of growing time for the Williams River and Dingo Creek sites respectively. Data was analysed for significance using a student's t-test.

The results for the Williams River and Dingo Creek sites are presented in Figures 4 and 5 respectively.

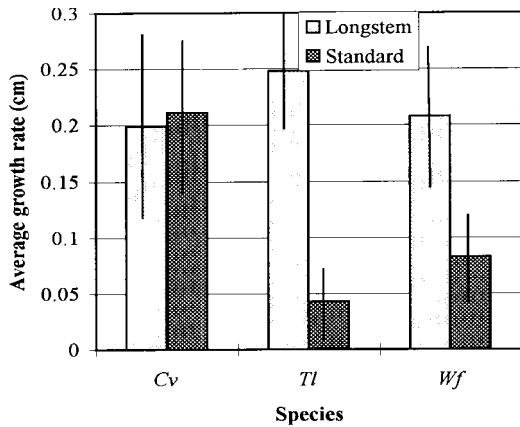


Figure 4: Average growth rates for *C. viminalis*, *T. laurina*, and *W. floribunda* comparing long-stem and standard tubestock. 95% confidence limits are shown. *C. cunninghamiana* was excluded due to damage from cattle.

At the Williams River site there was a significantly higher growth rate in the long-stem tubestock compared to the standard tubestock for both *T. laurina* and *W. floribunda* (Figure 4). No significant difference was recorded for *C. viminalis*. It should be noted, however, that the row of *C. viminalis* was planted closest to the water's edge, giving both treatments potential access to subsurface moisture.

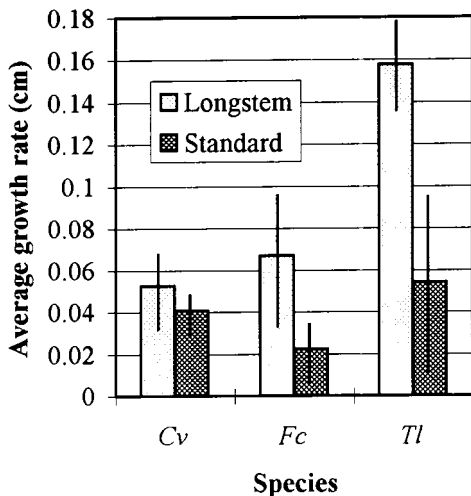


Figure 5: Average growth rates for *C. viminalis*, *T. laurina*, and *W. floribunda* comparing long-stem and standard tubestock at the Dingo Creek site. 95% confidence limits are shown. *C. cunninghamiana* was excluded due to no growth during the trial.

The trial site at Dingo Creek has only been established for six months, and therefore data should only be regarded as preliminary. There still was however a significantly higher growth rate for *T. laurina*, and a trend of increasing growth rates for both *C. viminalis* and *F. coronata* (Figure 5).

3.2.2 Survival Rates

Landholders recorded rainfall data at both trial sites over the study period. At the Williams River site, rainfall was below average for the months December 1997 to March 1998, and higher than average for the remainder of the study period. Rainfall was higher than average over the study period for the Dingo Creek site.

At the Williams River site a better survival rate was recorded for all species except *T. laurina*, which had similar survival rates between treatments (Figure 6). Differences were most marked between treatments for *W. floribunda* and *C. cunninghamiana*. These species were planted on the top of the bank slope and top of the bank respectively at a height of approximately 1.5 metres above low flow water level. The increased survival rates may be attributable to the ability of the long-stem tubestock to access subsurface moisture, however, further research would be required to verify this. It should also be noted that the plantings at the Williams River site were carried out into a thick cover of kikuyu grass, with no weeding undertaken prior to, or during the trial.

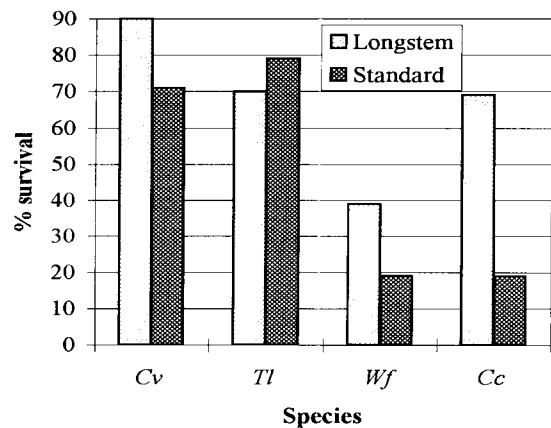


Figure 6: Survivorship between long-stem and standard tubestock for *C. viminalis*, *T. laurina*, *W. floribunda*, and *C. cunninghamiana* at the Williams River site.

No marked differences were recorded in survivorship at the Dingo Creek site. This may be attributable to the higher than average rainfall and the fact that weed competition was also initially less vigorous at the site. Survival rates following scouring could not be measured as no floods occurred over the study period. The greater depth of planting, however, would make plants less liable to removal from gravel bars by scouring.

3.2.3 Root Development

Plants of long-stem *Eucalyptus camaldulensis* were dug up from the initial trial site at Luskintyre to assess whether root development occurred along the buried stem. Root development was noted along the length of the buried stem (Figure 7), with roots developing from the growth nodes.



Figure 7: An 18 month old long-stem of *E. camaldulensis*. The lower white tag marks the top of the original tube, and the upper white tag marks the top of the buried stem. The distance between the tags is 60cm. Root growth along the buried stem can be observed between the tags.

At the other trial sites, both *T. laurina* and *C. cunninghamiana* were observed to produce adventitious root growth from the nodes.

4. CONCLUSIONS

The recent declaration of willows as noxious weeds within NSW has effectively prevented their further use for river management and stream bank erosion control.

Results from trials undertaken with native long-stem tubestock indicate that they offer a potential alternative to the use of willows.

Advantages in the use of long-stem tubestock over standard native tubestock include:

- increased growth rates;
- potentially better survival rates; and
- root establishment at depth.

The ability to plant long-stem tubestock at depth allows plants to access sub-surface moisture, and also potentially lessens competition for nutrients and moisture from the roots of weeds. The need for follow-up watering and weeding can, at most sites, be eliminated. More rapid growth rates and root development at depth provide more rapid soil stabilisation potential than standard tubestock. In harsh stream environments such as gravel bed streams, losses due to wilting and floods (as a result of scour) would be expected to be less due to the deep-rooted establishment of the plant. This latter point, in particular, allows long-stems to be planted in environments where only willows would be expected to have high survival potential and achieve rapid erosion control.

Results of the trials and other plantings in the Hunter Region indicate that many species have potential for use as long-stem tubestock and can tolerate burial of their stems for depths of at least up to 1 metre. Other species which have successfully established as long-stems include *Eucalyptus robusta*, *E. grandis*, *E. maculata*, *E. amplifolia*, *E. tereticornis*, *E. deanei*, *Melaleuca lineariifolia*, *M. styphelioides*, *Acmena smithii*, *L. polygalifolium*, *Acacia melanoxylon*, and *Casuarina glauca*.

Long-stem tubestock are presently \$1.80 per plant (standard tubestock range from 70c to \$1.50) and take about twice as long to plant as a normal tubestock on average.

Further research is required over a range of climates and stream-types within Australia to determine the applicability of long-stem tubestock to other locations.

A video showing how to grow and plant long-stem tubestock has been produced by Norkhil Technologies and will soon be available for purchase.

5. REFERENCES

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