CottonInfo

Native Revegetation Guide for Australian Cotton Growers

Revegetation to improve natural capital, ecosystem functions and services on cotton farms: 6 steps for success

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Best Practice

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ABOUT THIS GUIDE

THIS GUIDE IS FOR AUSTRALIAN COTTON GROWERS. IT OUTLINES THE SIX KEY STEPS FOR SUCCESSFUL NATIVE REVEGETATION IN COTTON LANDSCAPES.

Using this guide will help you plan, prepare, plant, grow and monitor revegetation sites on your farm. The guide is based on research by Dr Rhiannon Smith from the University of New England that investigated cost-effective methodologies for improving revegetation on heavy clay soils common in cotton catchments. The guide also identifies other relevant research and extension products and tools that can help inform revegetation projects on cotton farms.

Background

The Australian cotton industry is setting sustainability targets to improve its environmental footprint. The reasons for this are many: biodiversity is declining globally, and agriculture has much to contribute to global efforts to achieve the United Nations Sustainable Development Goal 15, Life on Land.

Australian cotton growers manage large land areas along the inland waterways of eastern Australia. While native vegetation covers 21% of an average cotton farm, only 4% is dedicated to conservation. These natural, structurally complex patches of remnant vegetation provide habitat for biodiversity. They contribute significantly to ecosystem services, such as natural pest suppression and carbon sequestration in farming landscapes.

This guide gives cotton growers practical and cost-effective solutions for restoring habitat connectivity, and monitoring and managing revegetation projects. It will be updated from time to time as new research and resources become available.

Acknowledgements

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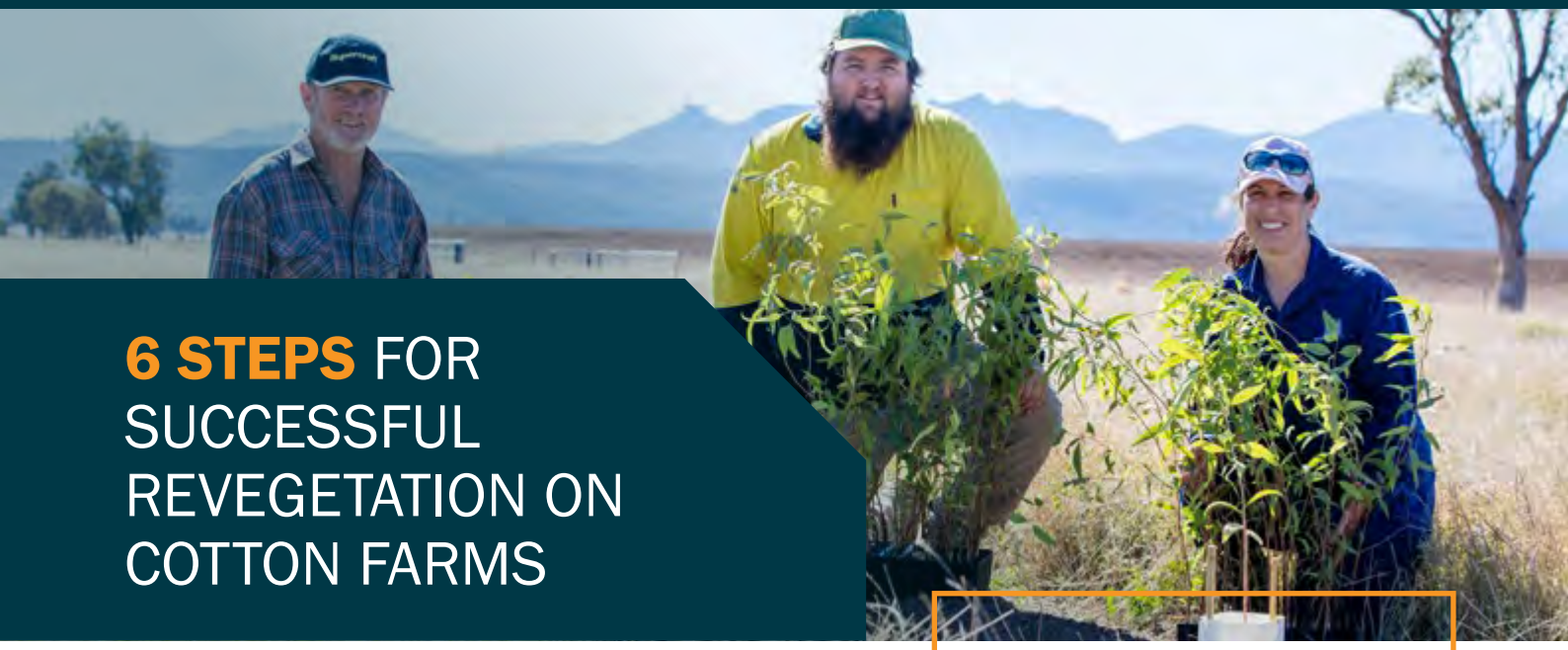
Benefits

Revegetation can provide many benefits to landholders, including:

- habitat for natural pest control agents, soil stabilisation and carbon sequestration
- shade and shelter for stock, windbreaks and amenity
- better ecosystem functions that support healthy environments, such as nutrient cycling, microclimate regulation and waste amelioration.

Revegetation can also attract economic benefits, such as agroforestry, natural capital and carbon accounting.

Revegetation programs may help meet sustainability goals and demonstrate good environmental stewardship.



6 STEPS FOR SUCCESSFUL REVEGETATION ON COTTON FARMS

STEP 1

Set goals.

STEP 2

Plan for success. Select the best site for revegetation. Know its history, characteristics and risks. Choose the best planting method.

STEP 3

Prepare the site to create the conditions for your plants to thrive.

STEP 4

Plant at the best time to give your plants the best start in life.

STEP 5

Grow the right species to ensure you have the right plants for your farm.

STEP 6

Monitor and maintain the site to measure your progress and record your success.

Funding for revegetation?

A range of government and non-government grants are available to help cover revegetation costs. Your revegetation plan may be required to be eligible for funding. Check the funding requirements and templates to make sure you can report correctly throughout and at the end of your project.

Community Grants Hub
communitygrants.gov.au

Landcare Australia
landcareaustralia.org.au/grants/

NSW Local Land Services
lls.nsw.gov.au

Fitzroy Basin Association
fba.org.au

Southern Queensland Landscapes
sqlandscapes.org.au

STEP 1: SET GOALS STEP 2: PLAN STEP 3: PREPARE STEP 4: PLANT STEP 5: GROW STEP 6: MONITOR

STEP 1.

SET GOALS: *Establish your revegetation goals.*

Before you start digging and planting, step back and think about your revegetation goals.

Clearly defined goals will guide your approach to the site and provide indicators to measure success (see Step 6).

Common goals for revegetation in agricultural landscapes include:

- Conserving biodiversity
- Using vegetative barriers to minimise spray drift
- Natural pest control
- Restoring riparian ecosystems.

Do you have a different goal?

Riparian revegetation protects assets, such as pump sites, from streambank erosion by slowing water movement through the landscape.

If you have different goals, some things will change – composition of species; planting density; site configuration; and timeframes for success.

Ask a natural resource management (NRM) expert for help to refine your goals and guide planting composition, spacing and configuration.

- RESOURCES -

Tips on planting nature corridors

Conserving biodiversity

Plants should include diverse vegetation species and types (trees, shrubs, and grasses). These provide many habitat and food resources for native and beneficial species.

Revegetation sites should link remnant vegetation patches to permanent water bodies. This improves the conservation value of your sites and provides connectivity for animals to move through the landscape. Corridors need to be as wide as possible (30 m minimum).

You can measure success by the number of birds or other animals, or the number of habitat resources (e.g. groundcover, litter, logs, dead standing trees or hollows, low shrubs, tall shrubs, trees). Nesting boxes can provide shelter in young plantings.

Using vegetative barriers to minimise spray drift

You can plant vegetative barriers (areas of vegetation) to:

» minimise risk of spray drift

» reduce odour and noise

» cut wind speeds in adjacent fields.

The most effective vegetative barriers to filter spray droplets:

» narrow vegetation strips (20 m wide) with good porosity

» height at least 1.5–2 times the release height of the spray

» species with long thin needle-like leaves, e.g. river she-oak (*Casuarina cunninghamiana*).

- RESOURCES -

Click here to prioritise areas for revegetation on your farm.

Click here to learn about using vegetative barriers to minimise spray drift on your farm.

Natural pest control

Perennial vegetation is a valuable alternative habitat for beneficials. It offers resources that are not found in cropping fields, especially when in fallow. While pest species can be found in native vegetation, most pests prefer exotic weeds to native plant species. Therefore, native vegetation has a low risk of increasing pests.

Like planting to conserve biodiversity, revegetation for natural pest control should include various species – different beneficials prefer different habitats and foods. Generally, flowering species, such as wattles, tea trees, bottlebrushes, and saltbushes, are likely to attract beneficial insects (see Table 1).

CSIRO has shown the benefits of keeping insect pest numbers lower for longer. Mirids are less likely in cotton in fields where 20% or more semi-natural habitat lies within a 2 km radius.

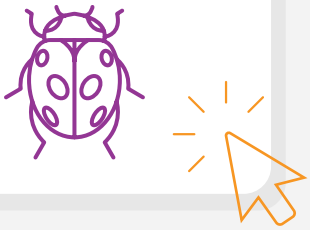
Restoring riparian ecosystems

You can design riparian zone revegetation to maintain ecosystems, make them resilient, and achieve your replanting goals.

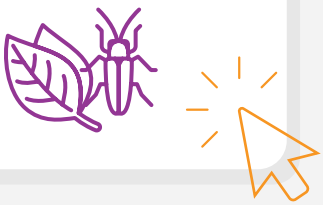
Table 2 (on the following page) is a useful guide for things to consider with riparian revegetation. It's taken from *Managing riparian ecosystems for ecosystem services and biodiversity: a handbook for the cotton industry* (Capon 2020). For example, riparian revegetation to stabilise banks should include areas low on a stream bank to help prevent slumping.

- RESOURCES -

Click here to learn about pests and beneficials on your farm.



Click here to read *'Keeping insect pests lower for longer: benefits of native vegetation.'*



Click here for more information on native species suitable for beneficial habitat in northern NSW & southern QLD.

Table 1: Flowering species to attract beneficial insects

COMMON NAME	BOTANICAL NAME	COMMON NAME	BOTANICAL NAME
Wattles (generally)	*Acacia*	Callistemon	*Callistemon*
black wattle	*A. salicina*	weeping bottlebrush	*C. viminalis*
river coobah	*A. stenophylla*	Saltbushes	*Atriplex*
weeping myall/boree	*A. pendula*	old man saltbush	*A. nummularia*
miljee	*A. oswaldii*	creeping/berry	*A. semibaccata*
brigalow	*A. harpophylla*	bladder saltbush	*A. vesicaria*
gundabluie/bardi	*A. victoriae*	annual saltbush	*A. muelleri*
Tea trees	*Melaleuca*	berry saltbush	*Rhagodia spinescens*
black/river/mock olive	*M. bracteata*	ruby saltbush	*Enchylaena tomentosa*
flax-leaf paperbark	*M. trichostachya*		
black paperbark	*M. lanceolata*		

Table 2: Riparian ecosystem functional attributes and management guidelines

FUNCTION	ATTRIBUTE	GUIDELINE
Shading	Vegetation height	Trees 5-20 m height
	Vegetation type	Local native trees, e.g.. *Eucalyptus rudis, Melaleuca rhaphiophylla* in the SW
	Vegetation density	High density (75%), continuous cover with several layers (Trees, tall shrubs)
	Buffer width	10 to 30 m wide (2 to 3 tree width)
Bank stabilisation & sediment filtration	Buffer width	Minimum 10 m width from the top of the bank
	Vegetation type	Include different plant structural types (trees, shrubs, grasses/sedges)
	Root type & density	Replant across a potential bank failure plane
	Position	Plant trees low on a stream bank to increase bank resistance to slumping
Nutrient filtration	Vegetation type	Include different plant structural types (trees, shrubs, grasses/sedges)
	Buffer width	Minimum 10 m width from the top of the bank. Grass/sedge buffer strip at the outer edge of riparian zone
Terrestrial/Aquatic Trophic subsidies	Vegetation type	Maintain native trees with overhanging branches that contribute leaves, flowers, fruits and terrestrial invertebrates to the stream whilst reducing erosion. Maintain aquatic vegetation for fish nurseries
	Ground cover	Reduce weeds, fire and other disturbances that reduce litter cover
	Vegetation structure	Maintain structure for terrestrial invertebrates and birds
Aquatic habitat	Vegetation type	Encourage growth of aquatic plants and tree roots within the water column
	Woody debris & leaf litter	Place large woody debris (LWD) with different orientations to bank and flow (parallel, angled, perpendicular). Leave overhanging tree branches. Retain leaf litter in pools and backwaters
Terrestrial habitat	Vegetation type	Retain native vegetation or local species, including plants with a range of food sources. Retain old trees with nesting hollows
	Vegetation structure	Include different plant structural types (trees, shrubs, grasses/sedges)
	Woody debris & leaf litter	Retain leaf litter, and retain or add woody debris as microhabitat for fauna
	Fire	Reduce fire frequency, maintain fire suppressant buffers (30 m at creeks, 50 m at rivers)
	Weeds	Remove weeds, encourage or plant natives. Fence to reduce disturbances (fire, recreational)

STEP 2.

PLAN: *Select your site and planting method.*

Select the best site for revegetation

Which vegetation community would occur naturally at the site?

In semi-arid and subhumid floodplain environments, water availability (e.g. flood frequency and duration) and soil type (texture and fertility) determine the way vegetation is distributed.

When establishing a new planting, try to choose species that replicate the original vegetation or that build on existing vegetation. This will improve survival and growth rates because your selected species will be adapted to local conditions.

Where a site has been transformed (e.g. through earthworks that change drainage patterns), you might have to deviate from naturally occurring vegetation to ensure your plantings adapt to new conditions.

The inland floodplain regions of NSW and southern QLD broadly consist of four key 'zones':

- active floodplains
- ancient floodplains
- riparian zone
- 'ridges' or prior stream formations.

- RESOURCES -

For more information on the main types of vegetation on cotton farms in your region, click here.

Diagram 1: Different storeys

Active floodplains

Before European settlement, grasslands and open grassy *Eucalyptus, Acacia* and *Casuarina* woodlands dominated the active floodplains; grasses dominated the understorey. In the midstorey, shrub species (e.g. emu bushes and lignum) were sparse.

In the swampy areas and run-on zones, shrubs (e.g. lignum and river coobah) dominated. Saltbushes were present, particularly where salt was present in the soil profile. As floodwaters receded, trees became established along debris lines to form dense, linear stands that self-thinned with droughts.

On these floodplains, heavy black and grey clay vertosol soils have key attributes that drive the distribution of woody vegetation. This includes the soils' shrink–swell action that responds to moisture availability.

The clay soil can also hold moisture tightly and stop plants from using it. As the clays dry and deep cracks open, the woody roots are exposed to the air. As a result, open woodlands and, sometimes, treeless plains are formed. Tiny pools ('gilgai') create areas of differential water availability (run-on and run-off), which promotes species diversity. For example, water-demanding (e.g. belah) and drought-tolerant species (e.g. brigalow) can grow together, creating diversity.

Ancient floodplains

This zone is dominated by brown clays that tend to crack less than grey and black clays. Therefore, vegetation can be quite dense, but generally shorter, because the soil profile has salt build-up and less moisture. *Acacia* species (e.g. weeping myall) dominate with a low chenopod (saltbush) and burrs understorey.

This zone is inundated only in very large floods. Because floods are infrequent, salt may persist in the surface soil; more frequent floods would force the salt down the profile. This characteristic favours saltbushes, other chenopods, and a different range of grass species spaced wider than those on heavy black or grey clays.

Riparian zones

The densest and most structurally complex woody vegetation is confined to riparian zones and run-on areas. Rivers and surface water support germination and early establishment of trees until they can access shallow groundwater reserves.

In the central and western plains, riparian forests are dominated by tall, dense eucalypts (e.g. river red gum, black box, and coolibah) with *Casuarina* (i.e. river she-oak) species on the low slopes of the Great Dividing Range.

The midstorey varies from sparse to dense shrubs dominated by acacia (e.g. black wattle or river coobah), tea trees, or a diverse mix of species, including boobialla, butterbush and emu bushes, as well as *Acacia* and tea tree species.

'Ridges' or prior stream formations

Red loam soil formations, generally only slightly higher than the floodplain, trace the path of ancient floodplain streams. They support more diverse vegetation, while the higher sand 'ridges' often support complex vegetation. Soils are coarser than the surrounding floodplains and don't crack.

In this zone in northern NSW and Central QLD, poplar box tends to dominate the overstorey. The midstorey is diverse, consisting of wilga, budda, turpentine, hopbush, whitewood, leopardwood, while the understory is sparse.

In the south, the midstorey is often dominated by myall, emu bushes, senna, mixed chenopods and sandhills of white cypress pine, scattered rosewood, and sub-canopy trees. The original shrub layer would have been diverse.

Table 3: Plants in four key zones of inland floodplains of NSW and QLD

COMMON NAME	BOTANICAL NAME
Active floodplains	
belah	*Casuarina cristata*
coolibah	*Eucalyptus coolabah*
black box	*E. largiflorens*
lignum	*Muehlenbeckia florulenta*
emu bushes	*Eremophila species*
black wattle	*Acacia salicina*
river coobah	*Acacia stenophylla*
Ancient floodplains	
weeping myall	*Acacia pendula*
saltbushes	*Atriplex species*
Riparian zones	
river red gum	*Eucalyptus camaldulensis*
river she-oak	*Casuarina cunninghamiana*
coolibah	*Eucalyptus coolabah*
black box	*Eucalyptus largiflorens*
black wattle	*Acacia salicina*
river coobah	*Acacia stenophylla*
tea trees	*Leptospermum spp.*
emu bushes	*Eremophila spp.*
boobialla	*Myoporum spp.*
butterbush	*Pittosporum spp.*
Prior streams/ridges	
poplar/bimble box	*Eucalyptus populnea*
wilga	*Geijera parviflora*
budda	*Eremophila mitchellii*
turpentine	*Eremophila sturtii*
hopbush	*Dodonea viscosa*
whitewood	*Atalaya hemiglauca*
leopardwood	*Flindersia maculosa*
white cypress pine	*Callitris glaucophylla*
scattered rosewood	*Alectryon oleifolius*
weeping myall	*Acacia pendula*

Know the site's history, characteristics, and risks

How was the land around the site used? How has past land use affected the site?

Past land use and current management will determine the time it takes for a site to mature. Weeds can also hinder maturity until it resembles a native, intact ecosystem. If the site was cleared, cropped or grazed, consider these soil constraints:

- landscape-scale changes in drainage patterns may affect floods or paddock-scale drainage
- limited soil fertility or overly fertile soils where there is a history of fertiliser use, or patchy distribution of fertility associated with grazing livestock
- no native seedbank
- weed species at or surrounding the site and in the soil seedbank.

Without intensive intervention, the site may have little chance of regenerating on its own – unless it's connected to high-quality remnants or has a viable native seedbank. In this case, you might have to start from scratch, i.e. high input costs and years building a self-sustaining ecosystem. But if the site is relatively intact, you might be able to build on existing elements.

A key feature of vegetation on semi-arid floodplains is its ability to recover quickly after disturbance (e.g., drought, flood or fire) or when favourable conditions return. Some native plants have natural adaptations, e.g. long-lived soil seedbanks and seed dormancy that assist in this recovery.

Succession: The process by which the composition, structure and function of an ecosystem change through time in response to disturbance.

Pioneer species – several important roles:

- recolonise a site, generally exotic species, or less desirable natives (e.g. daisies and roly-poly)
- capture material from other species, e.g. wind-borne seed heads of floodplain grasses
- provide refuge and protection from grazing animals (native and introduced). Then grazing-sensitive or shade-loving species germinate and establish
- initiate ecosystem functions, e.g. nutrient cycling
- build soil biology so that secondary species move into the site, making the ecosystem more mature. A succession of different species colonising the site after disturbance is vital to recovery.

Do you see this natural pattern occurring? When a site is still highly resilient, one option is to simply leave it for several years to move through this process:

- establishing pioneer weeds
- colonisation
- establishing late successional species.

The success of this approach depends on the site's history and connectivity (through wind, floodwater or fauna) with high-quality nearby remnants. If seed sources are available, or if site use has been short and seedbanks persist, nature can take its course.

But if the site is severely degraded, i.e. previously cropped or heavily grazed, there will be few native species and minimal habitat for fauna to disperse seed. To restore biodiversity values (composition, structure and function), you can expect to provide a lot of input over a long time, including planting tubestock to speed up the process.

Choose the best planting method

WHICH PLANTING METHODS ARE AVAILABLE? WHAT ARE THEIR LIMITATIONS?

Revegetation and regeneration

Depending on the site, many planting methods are available. If your site has some native cover, has a native seedbank, or can receive many native propagules via dispersal, you could focus on regeneration (natural and assisted) and augment existing vegetation.

Regeneration is:

- slower than revegetation, particularly when weather conditions impede seed germination
- significantly cheaper
- less labour intensive.

You can regenerate passively by providing artificial perches for birds. This method works well for berry chenopods (saltbushes) and other seeds that birds eat. Many floodplain grasses will re-establish at the site from windblown seed.

If seeds are not available in the site seedbank or surrounding landscape, you could try direct seeding or broadcasting for species with large seeds (e.g. *Acacia*). Use tubestock planting for other species, especially those with small seeds (e.g. eucalypts) that weeds can outcompete, or those for which seed is hard to find or expensive (e.g. threatened or endangered flora).

Assisted natural regeneration involves creating the right conditions for damaged ecosystems (communities of plants and animals) to bounce back. It usually includes managing threats, such as weeds and grazing, and applying triggers such as fire to stimulate regeneration. This approach is often called 'bush regeneration'.

Revegetation is the process of actively reintroducing appropriate plants, for example, by planting or direct seeding.

- RESOURCES -

Working with nature to improve the environment and profitability of irrigated cotton production at 'Kilmarnock', Namoi Valley, New South Wales

Table 4: Comparison of costing for different revegetation methodologies (2021 prices)

MANAGEMENT ACTIVITY	GST EXC	NOTES
Routine management activities for revegetation		
Fencing materials and labour	$1,000 per 100 m	required for all planting methods if grazing is present
Weed control before planting/seeding (spray out planting lines with glyphosate)	$150/ha	may not be necessary for drone seeding if planting into existing groundcover
Weed control after tubestock planting (hand spray haloes around plants and spot spray weeds on site)	$800/ha	if weeds are a problem, multiple weed sprays may be needed for seeding once plants emerge
Tree watering (labour and machinery)	$1/tree/water	once plants emerge, watering may be needed for seedings if climate conditions become dry
Tubestock planting		
Site preparation (rip and mound)	$200/km	depends on degree of compaction, machine used, etc. Can require two passes on each line
Weed control before planting (spray out planting lines with glyphosate)	$150/ha	
Tubestock seedlings (500 seedlings/ha)	$1.50–$2 per seedling	
Guards – milk cartons	$0.30 each	milk cartons or corflute may be used, but not both
Guards – corflute	$1.40 each	
Stakes – bamboo	$0.12 each	stake type depends on carton type; need two bamboo stakes per tree for milk cartons
Stakes – hardwood	$1.32 each	one stake per tree
Machine planting (modified vegetable planter)	$2/tree	less labour required, but savings offset by cost of machinery use
Hand planting (labour only)	$2/tree	hand planting using potiputki or Hamilton planter
Direct seeding		
Seed (2 kg/ha)	$700/kg	
Seeding – ute	$150/ha	
Drone seeding		
Seed (2 kg/ha)	$700/kg	
Bulking agent (kitty litter, 50 L/ha)	$35/30 L bag	
Drone operations	$650/ha	cost will vary, depending on overall size of planting area

Direct seeding

Generally, direct seeding for revegetation uses one or two row planters, with either tynes or discs, with or without press wheels or modified harrows dragged behind to cover the seed. You can tow a direct seeder behind a ute and cover a large area quickly. A direct-seeding machine built by KB Engineering in Deniliquin has been set up with mini opposed micro-mounding discs, flexi tynes for better tilth, seed sowing, and gypsum and herbicide application in one pass. This method is highly successful in temperate regions, but variable in semi-arid and subhumid areas.

Direct seeding requires a large amount of seed, which can cost hundreds of dollars per kg. There is no guarantee it will germinate and become established.

While seed costs hundreds of dollars per kg, the overall cost per hectare is generally lower than tubestock plantings when you factor in the other costs associated with tubestock plantings – trees, guards, and labour.

An advantage of direct seeding includes lower overall cost and stronger seedlings because they germinate on site – only the strongest genetic individuals survive. A key disadvantage is patchy planting, which isn't ideal for a windbreak or spray drift barrier. However, clumping of seedlings across the site can look more natural than straight lines, and it may reflect microsites (e.g. gilgais) with more suitable conditions for seedling germination and survival.

In high-rainfall temperate sites, intensive weed management after direct seeding is recommended because emerging plants might not compete well with established weeds. In some situations, a glyphosate overspray of direct-seeded sites in winter (when natives are not active and winter-active weed species grow rapidly) has been effective and created a mulching effect. However, existing groundcover can provide a better microclimate in hot, dry environments, and suppress more competitive weeds.

There is very little research into the role of residual herbicides in controlling weeds at direct-seeded sites.

Broadcasting seed

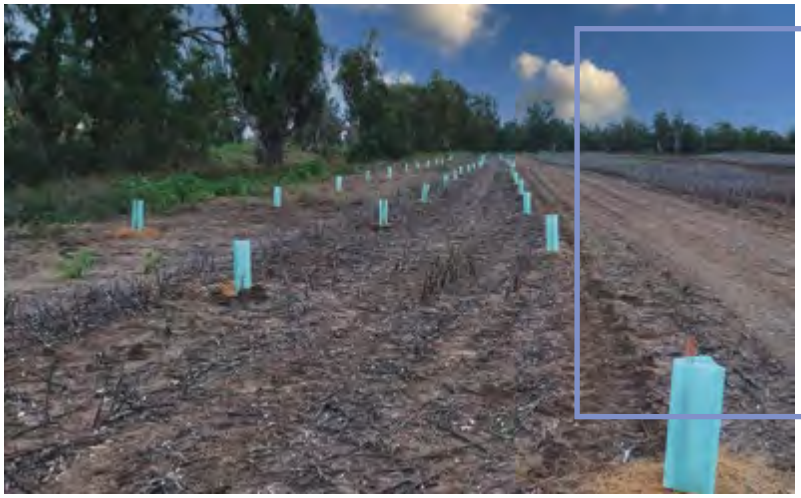
Broadcasting seed from a bike or ute, or even a drone or plane, might be an option in three situations:

» if the soil is saturated

» where you need minimal disturbance because of threatened flora or fauna

» where weed invasion is highly likely when disturbance occurs.

With the seed exposed to the elements to break dormancy, this method will most likely work during a wet season. Broadcasting black box seeds from a plane has worked at Barren Box Swamp, north of Griffith in Southern NSW, during above-average rainfall.



When you plan the configuration of the planting, consider access for weed control. Planting in lines makes maintenance easier but looks less natural. As a general rule, when planting tree lines to replicate a woodland and allowing for some losses, 5 m x 5 m is recommended.

Tubestock planting

Tubestock plantings need soil preparation, weed management, watering, staking and guarding for the seedings. While it seems expensive, tubestock planting is the most likely to succeed for most species and provides good outcomes in the short term.

In the first year:

- water regularly, particularly in late spring and summer if rainfall is low
- if the weed burden is high or the herbaceous vegetation is dense, prepare your planting lines in advance
- remove weeds frequently to reduce the weed seedbank.

Planting lines should be cultivated and mounded. For soils with very high clay content or high soil moisture, ripping might not be suitable. But it could help roots grow deep quickly and reduce compaction in loamy soils.

For large, open areas, you can use a modified vegetable planter *(photo 1, above)* to plant thousands of tubestock seedlings a day and simultaneously give them a small amount of water to lessen planting shock. Otherwise, plant seedlings by hand with a pottiputki device (*photo 2, above*) or a shovel.

Long-stem seedlings:

- help the root system establish deep in the soil
- have better access to soil moisture
- are 'anchored' better during flooding
- compete better with weeds because the root ball is below the competition zone
- are best suited in riparian zone species (e.g. river red gum, coolibah, she-oaks, black wattle, and river coobah), but rainforest species have also been successful.

Notify your nursery supplier at least 18 months before you need long-stem seedlings.

STEP 3.

PREPARE THE SITE: *Create the conditions for your plants to thrive.*

Make sure the conditions are right: threats, weeds, weed control, and herbivores.

Which threats are present? How will they influence revegetation? How can threats be managed?

In the semi-arid agricultural environments where cotton is grown, the greatest threats to revegetation are:

- drought
- prolonged flooding
- predators
- weeds
- poor planning and preparation
- inadequate management (or a combination of these).

Revegetation projects are challenging work in heavy clay soils with variable moisture availability. Sometimes, woody vegetation is naturally absent or sparse because of soil constraints.

Threats determine species selection, site preparation and post-planting management. To overcome these problems, you'll need significant inputs, e.g. gypsum to break up clays and overcome sodicity, and organic matter to stabilise aggregates.

However, input costs often outweigh the benefits, so carefully consider inputs in your plans.

Another threat is routine land management, such as chemical use, which can cause spray drift, or indirect transport in surface or groundwater. Some chemicals (e.g. herbicides, insecticides and fungicides) can harm native ecosystems, especially species composition, functions and service provision.

Weeds

The spread of invasive weed species, particularly grass species, is another threat. Seeds are spread by mowing, grading roadsides, or moving livestock. This threat is not specific to agricultural regions.

In riparian zones, floodwaters carry weed seeds, the soil is more fertile, and the microclimate helps plants grow. Because livestock access water in many riparian zones, nutrient levels can be high (from accumulated dung).

Weed seeds tend to concentrate around watering points where disturbance is high. Weed seedbanks are replenished when livestock visit the site.

Highly competitive weeds can take over, particularly when soils are disturbed and vegetation is cleared, removing competition. The increase in potential weed species, particularly in agricultural landscapes, makes recently disturbed sites vulnerable to invasion.

Some species, e.g. African boxthorn (*Lycium ferocissimum*), lippia (*Phyla canescens*), noogoora burr (*Xanthium occidentale*) and Bathurst burr (*Xanthium spinosum*), compete for moisture and hinder restoration, so you'll need a comprehensive weed control plan.

Weed control

Generally:

- use a broad-spectrum knockdown herbicide (e.g. glyphosate)
- for herbicide-resistant weeds, try other ways, e.g. repeated mowing, cultivation and even fire
- if the site is being prepared some time before planting, use residual herbicides
- if the site is dominated by native species that aren't particularly aggressive, minimising soil disturbance might be better
- if exotic, aggressive weed species dominate, scalping might give native seed or seedlings an advantage, i.e. remove existing plants, the surface seedbank and any surplus nutrient encouraging weeds.

  However, this method might not be appropriate for self-mulching vertosols with well-defined internal drainage patterns (e.g. gilgais).

Herbivores

When you plan tree-planting projects, think about numerous herbivores on cotton farms. Rabbits (in the sandy ridge zone where the stable soil suits burrows), hares (in the floodplain zone) and kangaroos pose a significant threat. They chew through stems of young seedlings or ringbark older seedlings.

In the floodplain and riparian zones, wild pigs pose a significant threat because they dig up newly planted sites. Livestock trample or eat seedlings when feed is scarce. Cockatoos can also make a meal out of newly planted seedlings and guards, particularly in riparian plantings. To control herbivores, put in sturdy fencing as part of your pest animal management program.

Be aware of soil constraints:

- compaction
- surface crusting
- nutrient imbalance
- low organic matter
- soil sodicity
- changes in soil ecology.

Soil compaction, surface crusting and sodicity

can affect growth of tubestock, and germination and root systems of direct-seeded plants.

For less severe compaction and surface crusting in cracking clay soils:

- leave the site untouched for several years to allow wetting and drying cycles and associated cracking and churning.

For severe compaction:

- deep rip (to 40–50 cm) to break the hard subsurface soil layer to help roots penetrate.

Note: Generally, deep ripping is not recommended for cracking clay soils, particularly if soil moisture is high enough to result in smearing.

For surface crusting on a site with low organic matter

(e.g. previously cropped or heavily grazed):

- plant a cover crop (e.g. a legume), spray out before maturity, and plough into the soil before cultivating and planting. Sometimes, adding gypsum is okay.
- add mulch, e.g., local weed-free straw, leaf matter from different species, jute or cardboard. If you use a straw (unless it's a pea straw), a fertiliser may need to be applied.
- mulch also keeps soil moisture and slows weed growth.

For sodicity in the subsoil, don't deep rip. It will bring salt closer to the surface, which affects plant growth and seed germination. If the surface soil is sodic, consider using more tolerant species, e.g. saltbushes, tea trees (*Melaleuca sp.*) and sandalwood.

STEP 4.

PLANT AT THE BEST TIME: *Give your plants the best start in life.*

Revegetation starts with **soil moisture** – it drives your site preparation and planting.

Dry soil:

» needs sufficient rain or watering shortly after planting.

Wet soil:

» Prepare the ground when the soil is dry – it limits compaction and smearing (soil particles realigned under spinning wheels or ploughs) (see Step 3).

» Find the best planting time in your area – avoid frosts but use seasonal rainfall patterns.

» Plant by direct seeding during cooler periods to avoid hot weather burning off seedlings.

» Plant tubestock during your local planting period.

You can leave sites prepared for some time before soil moisture is right for planting. But you have to **monitor soil tilth**, particularly when direct seeding. This is because aggregates can reform during cycles of soil wetting and drying.

Irrigate if necessary. Low humidity and high temperatures interact with low soil moisture, which increases evapotranspiration and water stress.

After you finish planting, **regularly check for problems** (e.g. predation, weeds, low soil moisture) and to guide how you manage the site. For tubestock in ideal conditions, watering should be needed only a few times.

Weed control for the first 12–18 months:

» regularly spot-spray weeds within a metre of seedlings (keep tree guards in place to avoid drift)

» keep some cover (e.g. sprayed-out cover crop or uncompetitive weeds between trees) to cool surface soil and to stop erosion.

Tree guards

Tree guards create a microenvironment around seedlings and protect them from herbivores. Generally, corflute guards are better than milk cartons at helping trees survive. They also help to provide trees with some protection from weed spray. Biodegradable and compostable guards are now available. They are more environmentally friendly than corflute (e.g. in riparian and active floodplain areas where floods wash guards away). When the tree has outgrown the guard, collect, dispose of, or reuse corflute and other plastic guards.

STEP 5.

GROW THE RIGHT SPECIES: *Ensure you have the right plants for your farm.*

Basic things to know about the species you want to grow:

- its ecology (e.g. distribution and abundance in your area)
- when they set seed
- amount and size of their seed
- how they disperse seed
- how to break seed dormancy (i.e. failure to germinate under normal conditions).

Australian weather patterns are highly variable. Therefore, specific conditions suitable for seed production, germination, and natural regeneration are rare on floodplains or confined to particular times and locations. Sometimes, we need to speed things up and get trees growing where we want them.

Seed dormancy: how to treat it

On floodplains, many dominant species use seed dormancy – they fail to germinate under normal conditions because they need flood-like conditions. Others need birds to crack the seed coat or remove chemicals that stop germination. These seeds might not germinate naturally for many years without treatment.

You need a licence to collect seeds, particularly in endangered or threatened ecological communities. Ask a local ecologist or revegetation practitioner for advice on how to treat seed dormancy and store seeds if you want to grow your own. For seeds with thick coats (e.g. *Acacia* and *Senna*), you might have to scarify the seed coat. For seeds of other species, you might have to treat with acid or wash with boiling water.

Different species also need different light (i.e. depth in the soil) and temperatures (in winter or summer) to germinate. Again, a local ecologist or revegetation practitioner can advise on species that are best for your conditions.

When you are direct-seeding or broadcasting, check that the seed is viable. Suppliers should have tested the seed to guarantee its viability. Ask the supplier for viability and collection records.

Is local always best?

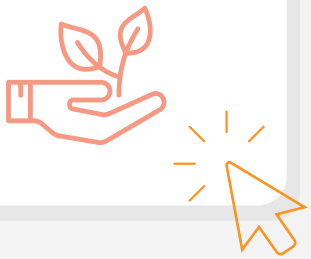
Generally, local seeds or seedlings help maintain genetic integrity of local populations. However, when plant populations are fragmented, individual plants can become genetically inferior. Also, climate variability can favour plants that adapt to changing conditions.

When no large local populations remain, you could try different sources:

- individual plants adapted to climate conditions
- individuals from large populations, but a wide selection of genotypes from various environments, not necessarily local
- seeds from local and adapted populations to ensure some germinate.

- RESOURCES -

A guide to revegetation on your property.



STEP 6.

MONITOR AND MAINTAIN THE SITE: *Measure your progress and record your success.*

What records should you keep? How will you know you achieved your goals? What can you do better next time?

Before starting your revegetation project, develop a detailed plan to ensure good record-keeping. The information you collect will help you adapt ongoing management.

The data on species planted, survival and growth, and performance of different provenances (seed source) will guide your selection of future species and provenances.

Records should include the following:

- planting date
- seed source and pre-sowing germination viability tests
- seed pre-treatment (dormancy-breaking treatments)
- planting methods (e.g. seed rates for direct seeding, fertiliser, irrigation, guards, mulches)
- site preparation methods and timing
- site maintenance and timing.

To monitor changes over time, consider setting up permanent photo points that can be revisited seasonally.

- RESOURCES -

Click here to watch CottonInfo video on setting up photo points.

CHECKLIST: GETTING STARTED!

Use this checklist to help plan your revegetation project.

PROJECT NAME:

PROJECT LOCATION (SITE): **SITE SIZE:**

STEP 1: SET GOALS.

My revegetation goals at this site are to:

- ☐ Conserve biodiversity
- ☐ Use vegetative barriers to minimise spray drift
- ☐ Encourage natural pest control
- ☐ Restore riparian ecosystems
- ☐ Other_____

STEP 2: PLAN FOR SUCCESS.

My site and planting method

- ☐ I've selected the best site for revegetation
  Think about: corridor connectivity, location for ecosystem benefits and farm operation.
- ☐ I know the site's long-term and short-term history, characteristics, and risks
  Think about: cropping history, climate, previous clearing, rainfall records.
- ☐ I've chosen the best planting method for the site
  Think about: tube stock, direct seeding, budget, seed availability.

STEP 3: PREPARE THE SITE.

I'll create the best conditions for my plants to thrive by responding to these threats and soil constraints:

- ☐ weeds
- ☐ herbivores
- ☐ compaction
- ☐ surface crusting
- ☐ nutrient imbalance
- ☐ low organic matter
- ☐ soil sodicity
- ☐ changes in soil ecology

STEP 4: PLANT AT THE BEST TIME.

I'll plant during these seasons because it will give my plant the best start in life.

Think about: rainfall, temperature and seasonal outlook.

- ☐ Spring
- ☐ Autumn

STEP 5: GROW THE RIGHT SPECIES.

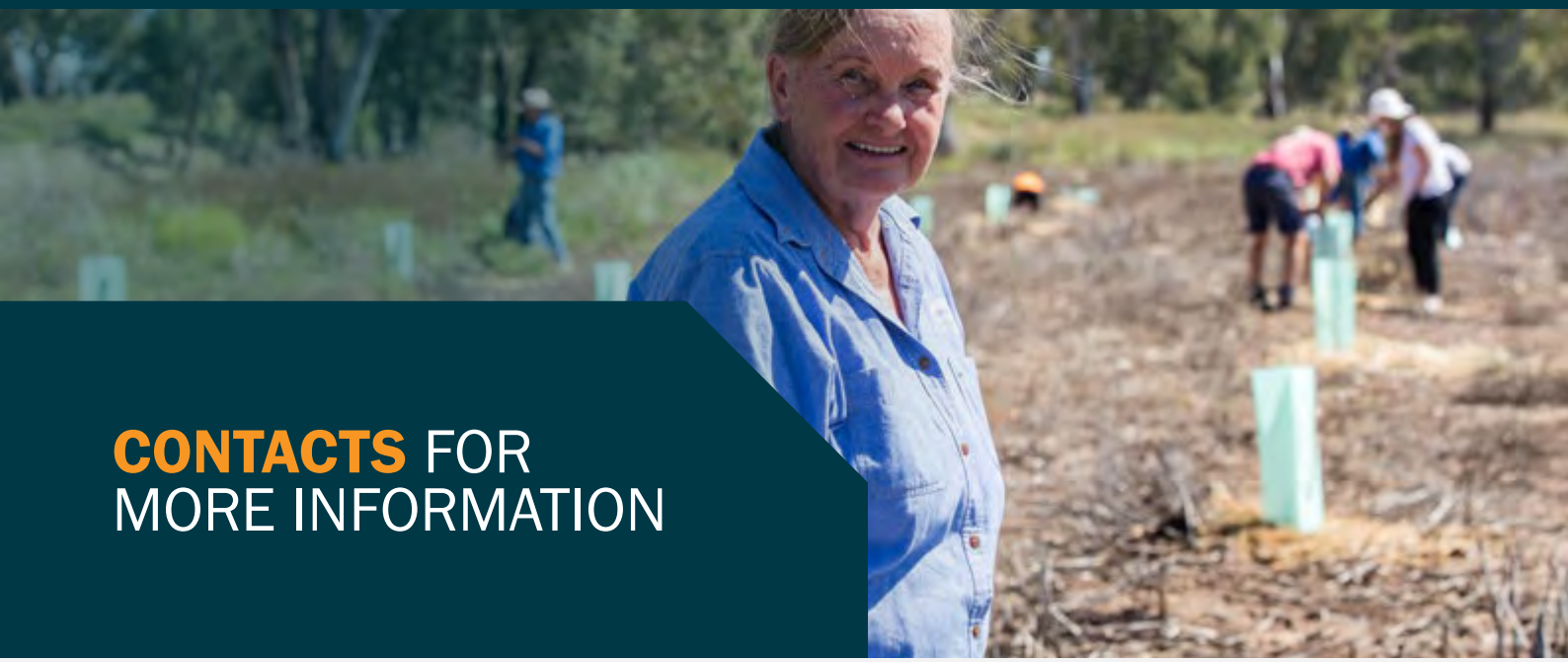
I've selected the species that are the right plants for my farm:

- ☐ Grasses
- ☐ Shrubs
- ☐ Trees

STEP 6: MONITOR AND MAINTAIN THE SITE.

Keeping these records will help me measure the progress and record the success of my revegetation project.

- ☐ Preparation, planting, and monitoring dates
- ☐ Site preparation activities
- ☐ Planting methods
- ☐ Photo points to monitor changes over time
- ☐ Species survival records
- ☐ Site maintenance



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Other helpful organisation and groups:

Regional natural resource management (NRM) organisations
nrm.gov.au/regional/regional-nrm-organisations

NWS Local Land Services (LLS)
lls.nsw.gov.au

Southern Queensland (SQ) Landscapes
sqlandscapes.org.au

Fitzroy Basin Association (FBA)
fba.org.au

Landcare Australia
landcareaustralia.org.au

Landcare NSW
landcarensw.org.au

Queensland Water & Land Carers
qwalc.org.au

Ozfish River Repair Bus (Murray Darling Basin)
ozfish.org.au/programs/river-repair-bus

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Cotton Landcare
TECH-INNOVATIONS 2021

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