A GUIDE TO PLANTING NATIVE TREES FOR FOREST RESTORATION IN WATERSHEDS

WISH
Watershed Interventions for Systems Health in Fiji

KIWA INITIATIVE
WISH+
Watershed Interventions for Systems Health Plus
WCS

https://doi.org/10.19121/2022.Report.43722

Cover photographs: WCS

Layout and design: Kate Hodge, Hodge Environmental

This document should be cited as:
Thaman B, Rounds I, Sue D, Thomas-Moko N, Tuiwawa M, Bolatolu W, Lesubula M, Lutua A, Waqa K, Mangubhai S (2022) A guide to planting native trees for forest restoration in watersheds. Wildlife Conservation Society. Suva, Fiji. 32 pp.

Acknowledgements
This manual would not have been possible without the expert knowledge and experiences of local forest and botanical experts from Conservation International, Ministry of Forestry, NatureFiji-MareqetiViti, and the University of the South Pacific.

We would like to acknowledge the writers, contributors, partner organisations, field workers and community members involved in the production of the previous training manual for communities from which this manual draws upon.

We would like to thank Bloomberg Philanthropies Ocean Initiative who provided support for development of this manual through the Watershed Interventions for Systems Health in Fiji (WISH Fiji) project, co-financed by the The Australian Government's Indo-Pacific Centre for Health Security.

The printing of this manual was funded by the Kiwa Initiative through the WISH+ project.

CONTENTS

INTRODUCTION

Why do healthy watersheds matter?

The land and sea are important because we rely on them for our health and wellbeing. A *watershed* is an area of land that drains into a particular point along a river, connecting land and sea. We are connected to watersheds through our cultures and traditions. We honour our ancestors by looking after the places that connect us to them as well as to one another, therefore we want to make sure to leave these places in good condition for our children, grandchildren, and great grandchildren.

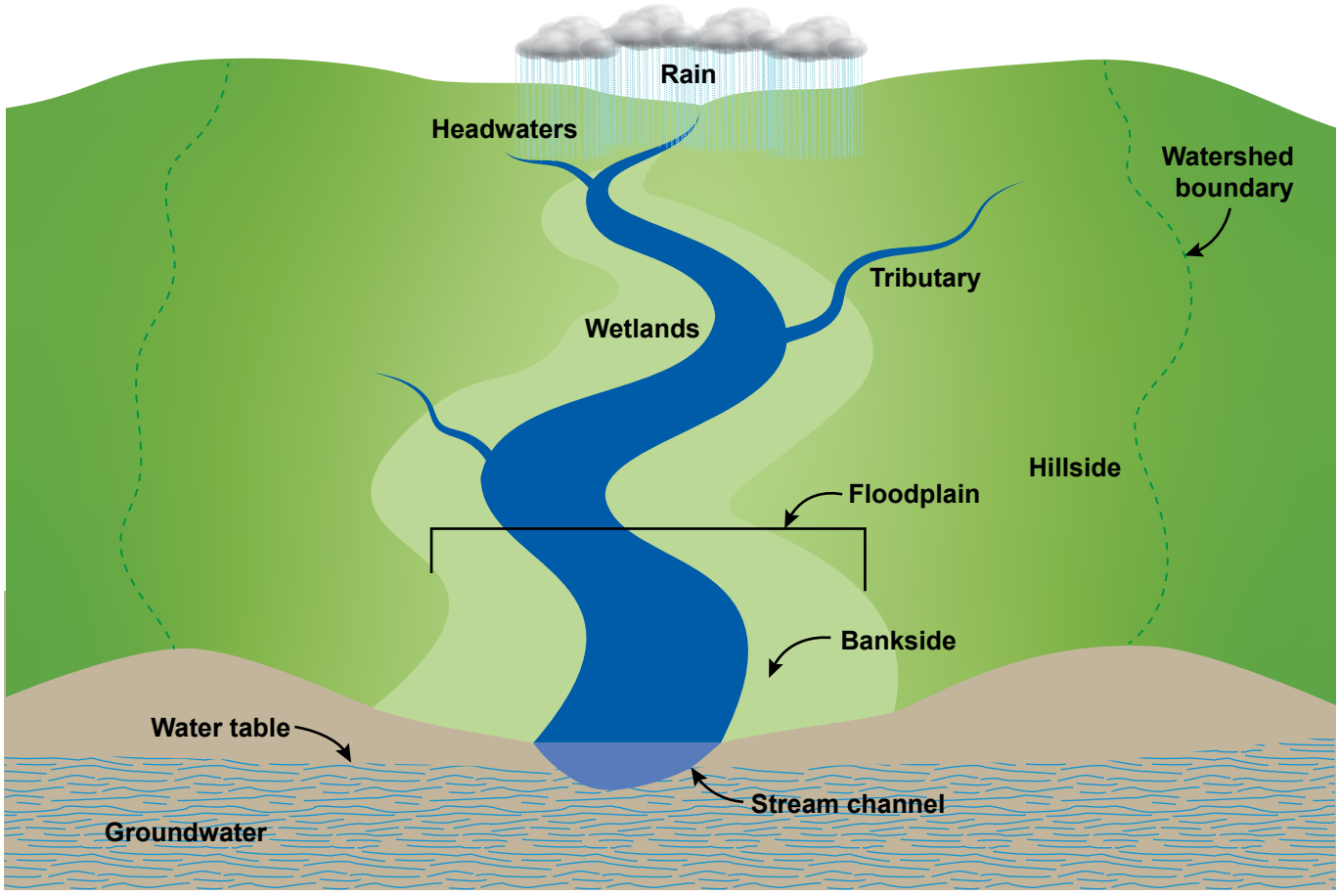


Figure 1. Components of a watershed.

In Fiji, rural communities are often very dependent on water in watersheds for drinking, domestic use, and recreation. Healthy forests with *native trees* are those that have existed for many years in a particular area and were not introduced by people.

Watersheds, especially those that have healthy native forests, complement the functions of lakes and other wetlands in high elevations in acting like sponges, by absorbing water from heavy rain, and slowing its flow into rivers.

Figure 2. Healthy watershed (left) and clean water flowing in streams (right). ©WCS

It is important to look after our watersheds because our activities at the top of our watersheds (mountain) will affect people living at the bottom of the watersheds (coast). For example, poor land management practices within watersheds, such as uncontrolled logging, poor agricultural practices, soil and gravel extraction, and uncontrolled burning, negatively impact downstream freshwater and marine resources and can affect the health of communities.

Figure 3. Examples of poor land management practices such as burning and planting on slopes. ©WCS

What role do forests play in watersheds?

When we cut, burn, damage or change forest landscapes, our health can be affected, as well as the health of other animals and plants that we rely on for food, traditional medicines, livelihoods and cultural practices.

Healthy forests and wetlands can help reduce soil erosion and the risk of flooding by stabilising the soil and regulating the amount of water that is in streams and rivers. When we cut down trees and farm on steep slopes, the soil can be easily washed away by rain and landslides. Soil that gets into rivers during heavy rain and flooding may also carry germs that can make us sick from water-borne diseases such as *typhoid* and *leptospirosis.* Water that collects on surfaces can act as breeding grounds for mosquitoes that can carry *dengue.*

In addition, when the soil leaves plantations through heavy rainfall, it often takes with it many healthy nutrients, making it harder to grow crops without adding extra chemical fertilisers. When we use chemical fertilisers on land near rivers, they can make the water unsafe to drink and can harm fish and plants that grow in the rivers.

Forests also have other important roles to play in the health and management of our watersheds. They include:

- providing seeds for plants to reproduce naturally
- helping to protect against strong winds, especially during cyclones
- keeping the surround areas cool
- acting as home for other plants and animals, many of which are only found in Fiji (for example *tagimoucia).*

Why is forest restoration important?

Unfortunately, a lot of our forest is being lost in uncontrolled ways, especially through burning, logging, and clearing for agriculture or settlements. These activities also make soils less fertile, can cause soil erosion, and can lead to landslides.

Forest restoration is therefore important because it ensures that all the important functions of forests in watersheds are properly maintained. We can achieve forest restoration through *reforestation* (*see text box below*) of cleared or degraded land.

Reforestation

The Fiji Ministry of Forestry guidelines define “reforestation” as broadly covering activities that include: tree planting using nursery raised seedlings, cuttings and wildings; direct seeding, in both plantation and enrichment planting; natural regeneration; and assisted natural regeneration.

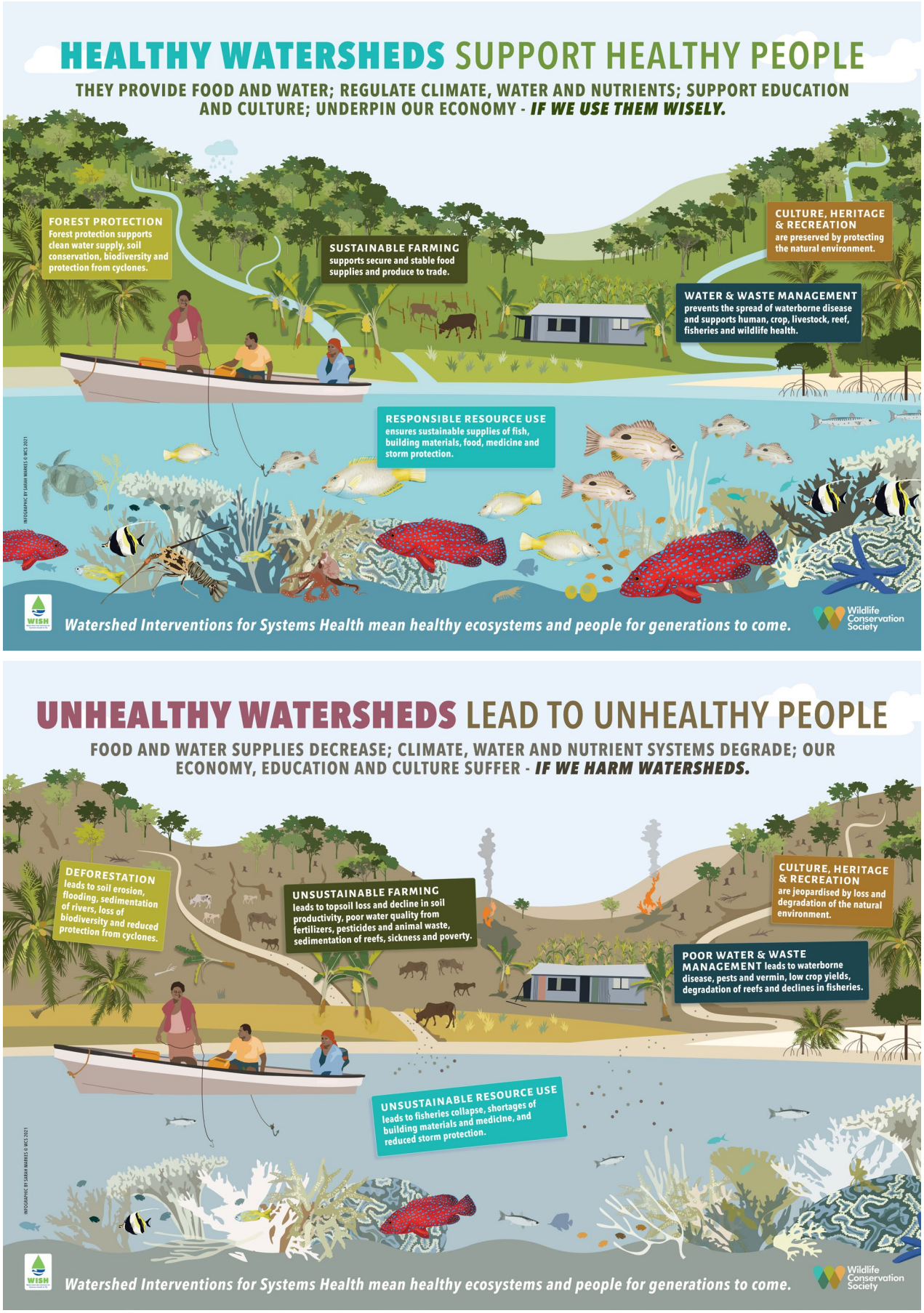


Figure 4. Healthy (top) and unhealthy (bottom) practices in watersheds. ©WCS

Purpose of this manual

The purpose of this manual is to help provide practical advice and guidance to communities to successfully carry out the restoration of degraded lands in Fiji, taking into account issues such as disaster risk reduction and climate change.

This is the second of two forest manuals that have been developed for rural communities to help them restore cleared or degraded land in their watersheds. These manuals can be used together in any forest restoration work.

In this manual, forest restoration refers to the replanting of native forest tree species aimed at repairing and restoring degraded land so that they can better meet the needs of local communities.

Figure 5. Cleared land requiring restoration of native trees. ©WCS

Key steps to forest restoration

Planting trees in the field requires proper planning, and preparation and is recommended before any forest restoration begins. If possible, you should consult with the Ministry of Forestry on the priority sites for restoration, including any baseline information that they may have on different sites. They will also be able to provide information on other potential sources of support for seedlings or personnel training.

Land owner participation and commitment is essential at all stages of any restoration programme. Wherever possible, reforestation plans should be integrated into community development and resource management plans. Any changes to the plans must be discussed and agreed by all the stakeholders, who should be made aware of the requirements needed for the project and expectations for contributions from all involved.

A timely supply of quality seeds or seedlings are important for the success of any restoration project involving tree planting. This should be incorporated into the planning prior to commencing the project.

You should also ensure that no existing native forests will be harvested, removed or damaged during the implementation of a restoration project.

Planting trees in the field is the result of many months of planning, seed collection and nursery work. Forest restoration sites are usually harsh. Seedlings need to be hardened beforehand, gradually exposing them to the environment outside the nursery to be able to cope well with the harsh conditions, and involves reducing the amount of shade and water that the seedlings get over time. If the planted trees are not protected and cared for properly, many will die and the efforts in producing them will be wasted.

Below are the six main steps of the restoration process:

Step 1. Site selection and preparation

Step 2. Species selection

Step 3. Planting techniques

Step 4. Buffer zones

Step 5. Fire management

Step 6. Post-planting management

Materials needed

- Supply of seedlings
- 1.5 m poles
- Pole/spring spades
- Cane knives and/or brush cutters with blades

STEP 1. SITE SELECTION AND PREPARATION

Once a site is selected, a general site assessment can be done and this will help you determine baseline information, such as: various *basic land types* (land with specific characteristics) found within the site: soil types; possible fire threats; existing biodiversity (plants and animals present); current and potential future land use practices; as well as the type of reforestation required.

A site assessment might involve activities such as a *rapid biodiversity assessment* of the site and/or participatory *community mapping exercises* for planning with community members. Biodiversity assessments are to find out what types of native plants and animals are already present in order to be able to select the appropriate tree species that are beneficial to them. Community mapping can help identify how people use forest resources for food and medicine to be able to select tree species that may also contribute to the community's needs.

In preparing sites for native forest restoration, steps should be taken to protect and encourage the growth of naturally established trees, seedlings and live tree stumps (*assisted natural regeneration - see text box below*).

The use of fires in preparing sites should be avoided as fires kill important soil organisms and can also spread out of control, damaging nearby forests or crops.

If there is a risk of livestock entering the replanted area, then fencing of the site might need to be considered. It is a costly option but it will give the planted trees the best possible chance for survival. The planting area should also be clearly marked with corner posts or with sprayed marks on boundary trees.

Site selection and preparation should be well documented to support continuous improvement for any future work in this area.

Assisted natural regeneration

Assisted natural regeneration is a simple, cost-effective method of forest restoration that should be tried first. It aims at helping to speed up the natural growth of existing native trees by removing or reducing some of the barriers to natural regeneration, such as soil degradation, competition from weeds, fire, grazing and harvesting. *Assisted natural regeneration* may be a good technique to test out in areas where there are already a lot of native trees growing and where these natural forests can act as sources of seed that can be dispersed through the wind or by animals.

This technique is good because naturally grown trees are best adapted to a particular place or site and therefore are more competitive. It also reduces the cost of propagating (in a nursery) and the need to plant trees. Native tree species, already growing on a restoration site, should be protected and assisted as part of the overall objectives of the restoration project.

If further active efforts are needed for restoration, then the information in this manual will be of use. For more information on *assisted natural regeneration*, please contact the Ministry of Forestry.

STEP 2. SPECIES SELECTION

When selecting the most appropriate tree species for reforestation, there is a need to consider both the *purpose* of the restoration project, as well as the land type required for reforestation. It is recommended that seedlings used for the project be from within the existing surrounding forests.

Identifying the purpose

Figure 6 lists some important questions to consider when trying to identify the purpose for a restoration project. You can do restoration for more than one reason.

Figure 6. Important questions to consider when trying to identify the purpose for a restoration project.

Identifying the land type

Once your purpose for planting has been considered, the land type to be restored will need to be identified. This is an important step as it will determine which tree species are best suited for that area. Some factors to be considered when determining your land type include:

- What is the slope of the site? (flat/slight/steep)
- Is the site near the sea? (coastal/inland)
- Is it an abandoned agricultural site?
- Are there streams/rivers within the site? (riparian/floodplain)

Land types include slopes, flats, gullies, creekbanks, riverbanks, ridges and soil erosion areas. *Figure 7* may be used to identify the different land type.

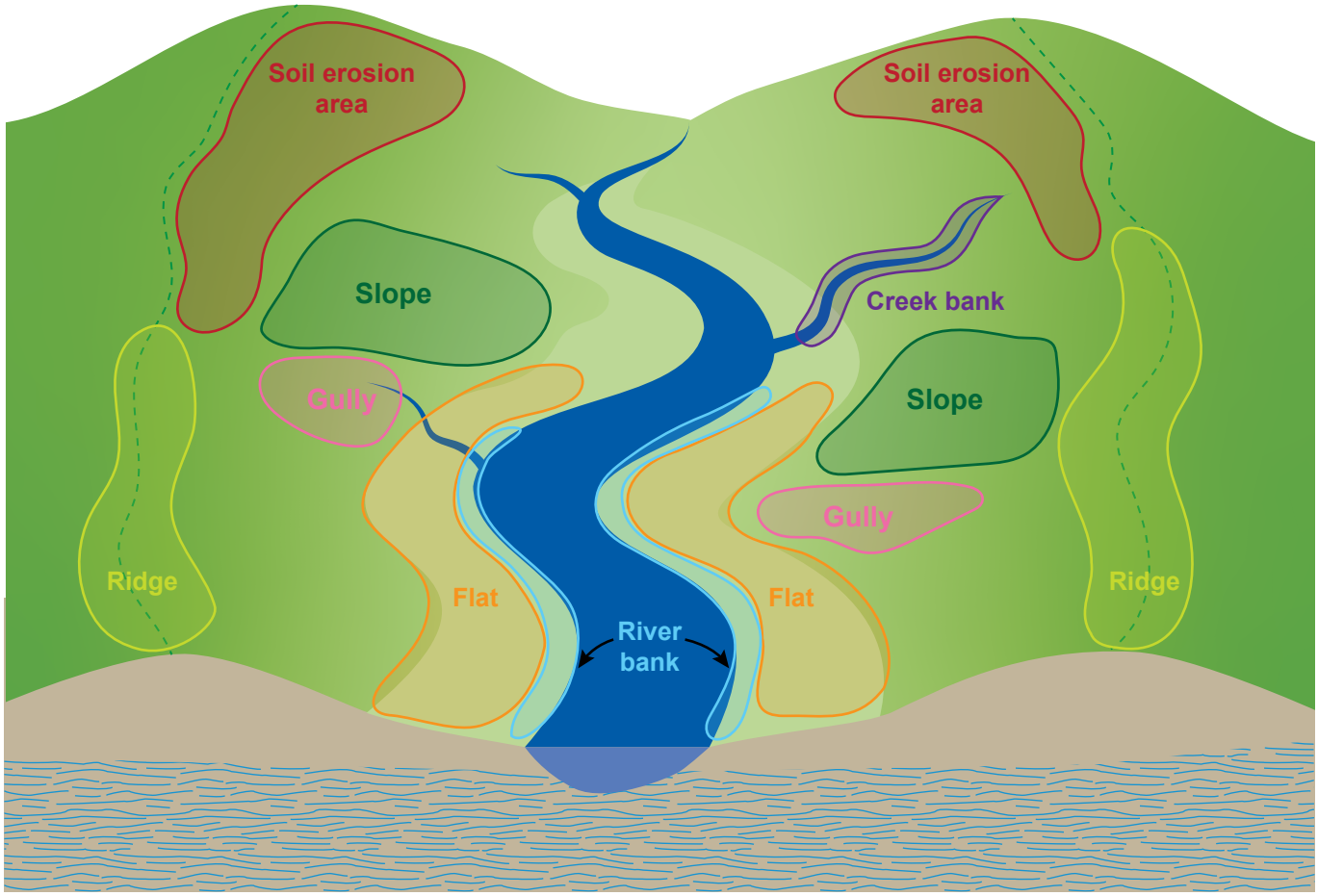


Figure 7. Conceptual diagram showing the different land types.

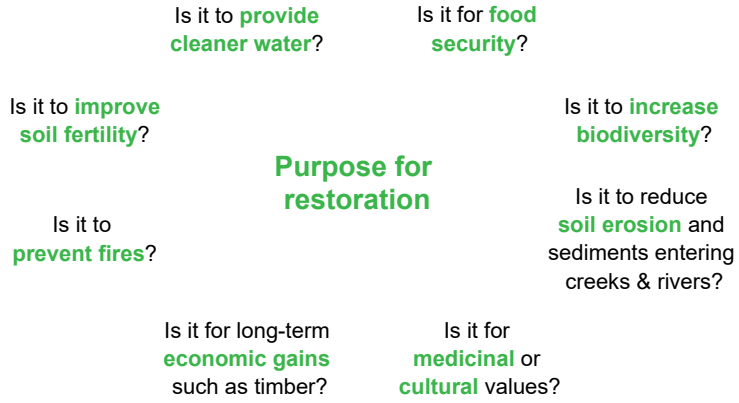
Once you decide on your purpose and land type to be restored, you may now select the best species to plant. The table at the back of this manual lists some recommended native tree species that may be used for restoration purposes and on which land type they grow best. However, *species selection is yours to make,* utilising the local knowledge held within your community on native tree species in your area and their uses, and what you may already have available in your nursery.

It is important to consult with as many different members of the community as possible, including men, women, the elderly, youth, farmers and foresters, as they each might hold different knowledge on what species were previously present on damaged or degraded land.

You may want to use a simple table like shown below, to help you decide which species you wish to plant.

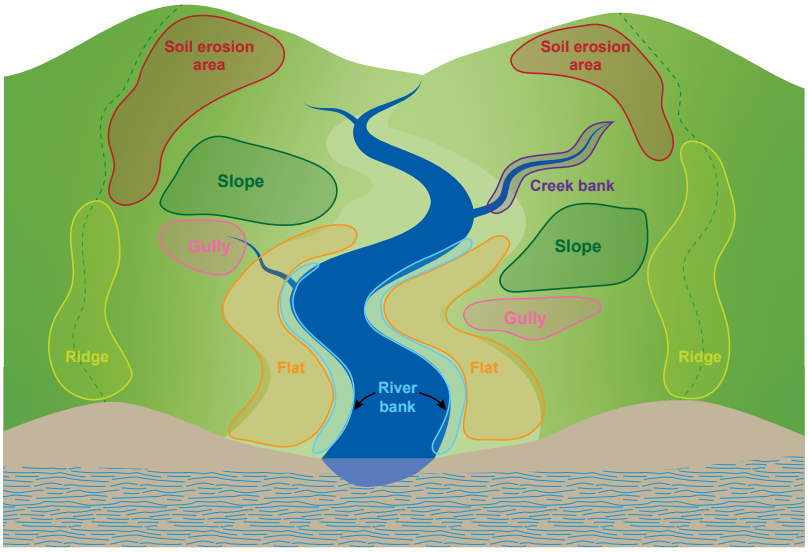
Purpose

- food security
- clean water
- biodiversity
- soil fertility
- reduce soil erosion
- prevent fires
- medicinal value
- economic gains



Land type

- slopes
- flats
- gullies
- creekbanks
- riverbanks
- ridges
- soil erosion areas



Species *(Choose ones that you know will grow well on the specific land type)*	**Reason for selection?** *(Examples below)*	**Does it grow locally?**	**Is it available in the nursery?**
Teak	Grows well in dry soil, Fast growing	No	Yes
Ivi	Grows well in wet soil, source of food	Yes	Yes
Yasi	Timber can be sold	No	Yes
Kura	Has deep roots to hold soil, medicinal value	Yes	Yes
Vesi	Cultural value	Yes	No

STEP 3. PLANTING TECHNIQUES

The planting techniques discussed here relate to the planting of plots that are about *1 hectare* (a little bigger than a rugby field). However, the techniques can be used as a general guide even for larger areas. For smaller scale planting, especially within village surroundings, the instructions below under *"Planting"* can be followed.

The best time to plant depends on water availability in the soil. Planting is best done in the rainy season to give planted trees sufficient water with less threat of fire. However, we recommend you start before the rainy season (September or October) to avoid planting in waterlogged soil. If planting in drier areas, you should start earlier in the rainy season once rainfall has become regular and reliable. Remember to do your seedling preparation (*see companion Nursery Manual*) before you start doing any reforestation work.

The three main techniques of planting

1. Spacing
2. Line spacing
3. Planting

1. Spacing

The first step is to establish the *spacing* of each tree, which is a set distance apart within the selected restoration area. This is done with poles to determine how many seedlings are needed for planting. Spacing can be done in lines, for ease of planting, or randomly, to mimic natural forest spacing.

- First, establish your *baseline* from where all spacing and planting will begin from (*see Figure 8 below*).

This is important as it determines the eventual planting process. For steep or sloping land, for ease of planting, it is recommended that the baseline be set perpendicular to the slope so that spacing extends horizontally across the slope.

In this case, we recommend a standard plant spacing of *6 metres* but this can vary according to the species being planted. Planting *6 metres* apart will allow space for the tree to grow and spread its branches.

- Then, moving out perpendicular from your baseline, place *1.5 metre* poles *6 metres* apart, in lines or randomly (*see Figure 8 below*).

If planting is to be done in lines, then we suggest you follow the contours of the land (*contour planting*) with a *6 x 6 metre* pattern as shown in the diagram below. If planting is to be done randomly, you should ensure, through estimation, that the poles are about *6 metres* away from each other in any given direction.

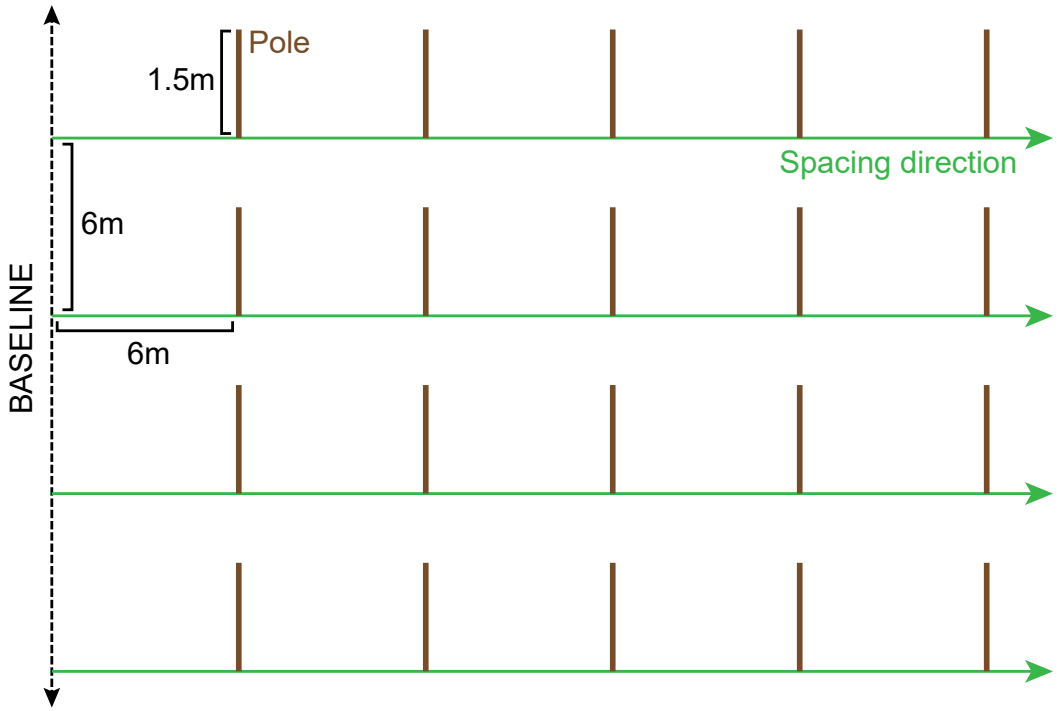


Figure 8. Recommended layout for spacing.

Figure 9. Spacing. ©WCS

Reforestation in degraded areas with no forest cover requires closer spacing. In established forests, spacing may need to be wider as there are other trees competing for sunlight as well as soil nutrients.

2. Line-cutting

Your next step is *line-cutting*. The main purpose of this is to protect the new trees from the surrounding vegetation. It also allows for easy access to the new trees for the purposes of care and monitoring.

- Starting from your baseline and working all the way along your pole lines, clear *1 metre* on all sides of the poles.

In the end, strips of *2-metre* widths should be cleared all the way along the planting lines, or circles around the random poles.

In dry areas or grasslands, the total width or diameter of planting lines or circles to be cleared may be reduced to *1 metre* for moisture retention purposes in the soil.

Figure 10. Line-cutting. ©WCS

3. Planting

The table at the end of this manual can help you decide which species are suitable for planting in the different land types and also has information on how old seedlings should be when planted out.

Before the actual planting begins, seedlings should be brought to a temporary nursery area close to your planting site, 1-2 days beforehand to acclimatise to their new environment without any disturbance to their roots.

- If it is a hot day, dip the seedlings in water before gently removing potting bags, taking care not to disturb the roots or let the soil crumble away. *Please collect and carry back with you all used potting bags to be disposed of properly.*
- Dig holes and place seedlings in holes without disturbing the roots.
- Using your feet, compress the soil around the seedling to ensure there are no air pockets.

Figure 11. Examples of tree planting. ©WCS

STEP 4. BUFFER ZONES

The vegetation that grows alongside creeks and rivers (*riparian*) is important as it stabilises creek and riverbanks, stopping them from collapsing during flooding events and also maintains creeks and rivers for a continuous supply of clean water. The areas in which riparian vegetation grows acts as *buffer zones* and should always be vegetated. Research from Fiji has shown in particular that there are more cases of water-borne diseases like *typhoid* when riparian vegetation in the buffer zone has been cleared.

For restoration in the buffer zone, native tree species with adventurous roots like *ivi, tavola, vesiwai, vesi, tarawau-kei-rakakā, vutukana, vau* and *yaro* can be planted. Nearer to settlements, *vutukana, vutuwai, ivi, coconut, dawa, manqo, pandanus,* and *vuturakaraka* are suitable. Further inland, *yasiwai, kuluva,* and *lolotagane* are more adapted. *Vetiver grass* is also very effective for stabilising creek and riverbanks (refer to the table at the back of this manual for further information on plants adapted to riverbanks and creekbanks).

The size of your buffer zone depends on the size of the creek or river. Larger creeks and rivers have wider buffer zones. Experts recommend that buffer zone strips of at least *ten metres* should be maintained on either side of smaller creeks and up to *50 metres* on either side of larger rivers.

Figure 12. Forest reforestation in the buffer zone. ©WCS

STEP 5. FIRE MANAGEMENT

Most of the degraded areas in the country are covered with non-native *talasiga* grassland and are prone to fire caused by humans. Humans burn the land for various reasons such as hunting and farming. However, fire is one of the main threats to the survival of your newly planted trees and must be taken seriously. Your newly planted trees need protection from fire until they can out-compete the non-native grasses.

Many things increase fire risk, including drought, high winds, steep slopes, and dry vegetation available to burn (*fuel load*). Managing these things (fire management) is an important step to stop fires from reaching the planted areas by reducing its intensity. This can be done by creating *firebreaks* and should be incorporated into the restoration process from the beginning.

A firebreak is an area of land where vegetation is completely removed and only bare soil is left. Fruit trees or plants that are fire-resistant can be planted in the firebreak and the advantage of this is that it converts the firebreak into a garden that will be maintained at regular intervals, reducing the risk of fire.

We suggest you plant *pineapple*, *mango*, *jackfruit*, *breadfruit, coconut* or short-term root crops like *cassava* or *kumala* that could also provide food security and income. In areas where there is a high threat of fire, then it is best to leave the soil bare without planting.

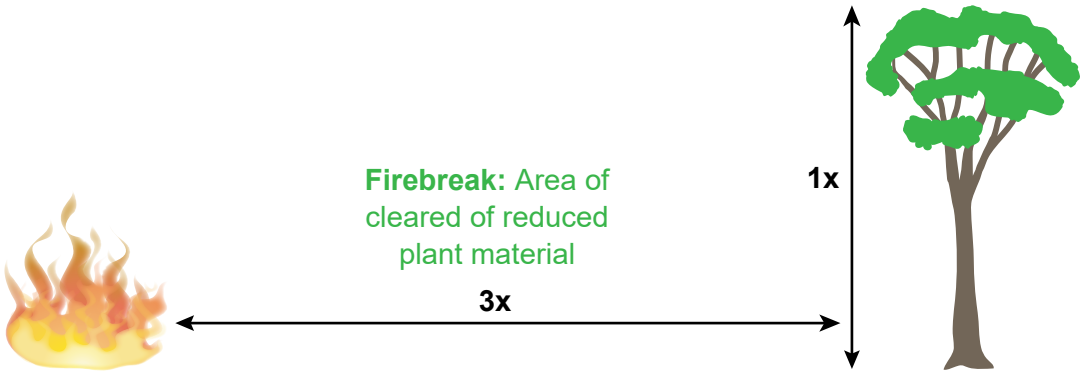


Figure 13. Firebreak area

How to clear firebreaks

Firebreaks are most effective at ridge tops or at the base of slopes and should also be cleared along the boundary of the planted area. Fire will spread most rapidly in the direction that the wind is blowing and therefore they should also be generally situated perpendicular to prevailing winds. They should be cleared right down to the ground level, totally removing all vegetation that may become fuel load to burn.

Firebreaks should be at least *three times* wider than the maximum height of existing vegetation, such as grassland or other shrubs. For example, if the area contains grass *1 metre* in height, then you should clear at least *3 metres* as the firebreak.

Figure 14. Firebreak with beans planted in between trees. ©WCS

Community awareness on the threat of fire is encouraged. Fire wardens can be assigned in each community and fire patrols can be organised to detect and stop approaching fires before they can spread to the restoration site.

STEP 6. POST-PLANTING MANAGEMENT

Post-planting management is important in any reforestation work. You should undertake regular field inspections of the planted areas to check on tree growth and threats to help make better informed decisions on the most appropriate management strategies and activities.

Protecting reforested areas from fire and livestock is important for the success of the restoration project and should be monitored constantly. The best way to prevent their encroachment to the reforested area is to mobilise the support of everyone in the community.

Survival monitoring and weeding can be carried out together and depends on the year of growth and amount of rainfall which will affect both seedling and weed growth.

Post-planting management activities

1. **Fire management**
2. **Livestock management**
3. **Survival monitoring**
4. **Weeding**

Suggested management schedule for survival monitoring and weeding

Year 1 : every 2-3 months

Year 2 : every 3-4 months

Year 3 : every 6 months

Year 4 onwards : once a year

1. Firebreak management

Firebreaks must be maintained *2-4 times per year* to control the build-up of the fuel load, which greatly increases the chance of fire. Firebreak management involves weeding the total width of the firebreak to remove all vegetation (apart from planted trees or crops)

2. Livestock management

You should avoid keeping livestock (cattle, goats or horses) in the replanted area to prevent the accidental grazing and trampling of newly planted trees. If the area contains livestock, these animals should be moved elsewhere where they are out of reach of the planted trees, or kept within fenced areas.

3. Survival monitoring

Survival monitoring means finding out whether the planted trees have survived and are growing well after the first few years after planting, and to check if the initial purpose for restoration is being achieved.

Survival monitoring of the planted trees in restoration areas involves measuring tree growth and survival by recording details such as:

- Site information
- Species names
- Survival status (Dead/alive)
- Growth measurements (tree height and crown width (top branches))
- Recruitment data (any new seedlings from the parent plant)

An example of how survival data can be recorded is shown below.

Site: Upper catchment

Mataqali: **Staff:** Ana/Pita

Date: 24/03/2022 **Time:** 11:30

Row/line #: 5

Tree #	Species	Status *(alive/dead)*	Tree height *(cm)*	Crown width *(cm)*	Recruitment *(# of seedlings)*
1	Vesi	Alive	155	86	-
2	Kura	Alive	87	66	13
3	Teak	Alive	234	102	5
4	Ivi	Dead	-	-	-
5	Dawa	Alive	150	90	-

4. Weeding

Tree growth will be better if weeds can be controlled in the direct area surrounding each tree as it reduces competition with other plants around it, ensuring they receive sufficient sunlight and nutrients.

Weeding is specifically important in the first two years after planting to avoid high tree deaths. How often you should weed will depend on how fast the weeds grow, and if rains are continuous, weeding may be needed every *4-6 weeks*.

Mulching of the weeded material in the direct area surrounding the tree can be done to retain soil moisture, slow down weed regrowth and reduce soil erosion.

Figure 15. Weeding around trees. ©WCS

NATIVE AND NATURALISED TREE SPECIES USED FOR FOREST RESTORATION

Listed in the table below are tree species that can be planted in **A. degraded land** and **B. badly degraded land.** Information is provided on their land type suitability, flowering and fruiting months, growing methods, and other details such as seed pre-treatment/sowing position/germination time.

*NOTE: Species listed under **badly degraded land** and **others** also qualify for **degraded land.** Species highlighted in light green are naturalised (non-native) useful species that may also be used for forest restoration.*

Local & botanical name(s)	Suitability	Flowering (fruiting) months	Growing methods	Seed pre-treatment/sowing position/ germination time and notes
A. DEGRADED LAND (species NOT recommended for *badly degraded* land below)				
Baka-ni-viti *Ficus obliqua*	Slopes, flats, gullies	Year-round	Seeds	No seed pre-treatment is required.
Cadamba *Neolamarckia cadamba*	Slopes, flats	June-Aug	Seeds	Soak fruits until rotten, then mash by hand and air dry. Pass through a sieve to obtain seeds. Sow in trays. When the seedlings are 8-12 weeks old, transplant to plastic bags. After 6-7 months, when the seedlings are about 30 cm tall, transplant into the field.
Dawa *Pometia pinnata*	Creekbanks, flats	Dec-Mar (Jan-May)	Seeds	No seed pre-treatment is required. Large seeds that can be planted directly in potting bags. Seeds will lose viability if dried. Germination in 7-10 days.
Doi *Alphitonia zizyphoides*	Gullies, slopes		Seeds	Pre-soak seeds in water for 12-24 hours. Sow in trays in a sunny situation. Some seed lots take several months to germinate. Should be transplanted to individual containers at the four-leaf stage. Seedlings are ready for planting out after about 16-20 weeks when they are about 25 cm tall.
Drou *Trema cannabina*	Slopes, flats, gullies		Seeds	No seed pre-treatment is required. Needs well-drained sandy soil.
Drou, Drouvula *Parasponia andersonii*	Slopes, flats			No seed pre-treatment is required.

Local & botanical name(s)	Suitability	Flowering (fruiting) months	Growing methods	Seed pre-treatment/sowing position/ germination time and notes
Ivi *Inocarpus fagifer*	Creekbanks	Year-round (twice)	Seeds, cuttings	No seed pre-treatment is required. The large can be sown directly into potting bags. Can be transplanted to their permanent positions about 2 months after germinating, when about 20-30 cm tall. seeds should be buried at a depth of 3–5 cm. Germinates in 7 days.
Koka *Bischofia javanica*	Slopes, flats, gullies	Aug-Nov (Feb-June)	Seeds, cuttings	No seed pre-treatment is required. Germination starts 13 weeks after sowing.
Kuluva *Dillenia biflora*	All terrain	Year-round	Seeds	No seed pre-treatment is required.
Losilosi *Ficus vitiensis*	All terrain	Year-round	Seeds	No seed pre-treatment is required.
Mako *Trichospermum calyculatum*	Slopes, flats	Year-round	Seeds	No seed pre-treatment is required.
Makoloa *Trichospermum richii*	Slopes, flats	Year-round	Seeds	No seed pre-treatment is required.
Molau, Molauyalewa *Glochidion seemannii*	Slopes, flats	Year-round	Seeds	No seed pre-treatment is required.
Molaudamu *Glochidion concolor*	All terrain	Year-round	Seeds	No seed pre-treatment is required.
Molautagane *Glochidion vitiense*	Slopes, flats	Jun-Jan (Dec-Feb)	seeds	No seed pre-treatment is required.
Nuqanuqa *Decaspermum vitiensis*	All terrain	Year-round	Seeds	No seed pre-treatment is required.
Sama *Commersonia bartramia*	slopes	Year-round	Seeds, cuttings	No seed pre-treatment is required.
Tadalo *Homalanthus nutans*	slopes	Sept-Dec	Seeds, cuttings	No seed pre-treatment is required.
Tadano, Vuetinaitasiri *Pagiantha thurstonii*	Slopes, flats, gullies	Year-round	Seeds	No seed pre-treatment is required.
Tarawau-kei-rakakā *Dysoxylum richii*	Slopes, flats, gullies	Apr-Jul	Seeds	No seed pre-treatment is required.

Local & botanical name(s)	Suitability	Flowering (fruiting) months	Growing methods	Seed pre-treatment/sowing position/ germination time and notes
Vadra *Pandanus tectorius*	slopes	Mar-May (Feb-Apr)	Seeds, shoots	Soak in cool tap water for 5 days, and change the water daily. Seeds will lose viability if dried. Germination in 7-70 days. Grow from shoots during the growing season.
Vakaceredavui *Tarenna sambucina*	Slopes, flats			No seed pre-treatment is required.
Vau *Hibiscus tiliaceus*	All terrain	Year-round	Cuttings, seeds	Soak seeds in water.
Vesi *Intsia bijuga*	Creekbanks, slopes	Year-round	Seeds	Soak in boiled water for 2 hours and dry for 24 hours at room temperature. Sow 5-7 mm apart and 3 mm deep with 'pointed' end up and tip just emerging from the surface of soil. Germination in 17-41 days.
Vuetinaitasiri *Ervatamia obtusiuscula*	All terrain			No seed pre-treatment is required.
B. BADLY DEGRADED LAND (species ALSO recommended for *degraded* land above)				
Ai masi *Ficus barclayana*	Slopes, flats	Year-round	Seeds	No seed pre-treatment is required.
Bitudina (bamboo) *Schizostachyum glaucifolium*	Slopes, creekbanks	-	Shoots	No seed pre-treatment is required.
Koka *Bischofia javanica*	Slopes, flats, gullies		Seeds, cuttings	No seed pre-treatment is required. Germination after 1-3 weeks.
Kuluva *Dilenia biflora*	Slopes, flats	Mar-Nov		No seed pre-treatment is required.
Kura (Noni) *Morinda citrifolia*	All terrain	Year-round	Seeds	No seed pre-treatment is required. Sow in nursery beds. Germination in 3-9 weeks. Deep taproot, good for holding soil.
Laūci, Sikeci *Aleurites mollucanna*	Gullies, slopes	Year-round	Seeds	Seeds are hard-shelled, and untreated seeds stay in a seedbed for as long as 38-150 days before germination. For faster germination, the seed can be cracked.
Macou *Cinnamomum pallidum*	Slopes, flats			No seed pre-treatment is required.

Local & botanical name(s)	Suitability	Flowering (fruiting) months	Growing methods	Seed pre-treatment/sowing position/ germination time and notes
Mangium *Acacia mangium*	Slope, flats		Seeds	Seed should be submerged in boiled water then cool for 24 hours. The swollen seeds should be sown immediately. Germination in 1-15 days. Young seedlings potted when large enough to handle, and can be planted out when 25 cm tall, usually after about 16 weeks.
Mango/Maqo *Mangifera indica*	Flats, ridges		Seeds	No seed pre-treatment is required.
Qumu *Acacia richii*	Slopes, flats	May-Dec	Seeds	Has a hard seed coat. Pour a small amount of nearly boiling water on the seeds being careful not to cook them and then soaking them for 12-24 hours in warm water.
Tamarind *Tamarindus indica*	Slopes		Seeds	Pre-soak the seed for 24 hours in warm water and sow in a seed bed. Grow in seedbed for more than 4 months before being transplanted.
Tavola *Terminalia catappa*	Creekbanks	Jan (Mar-Jul)	Seeds	It is recommended that seeds are sown within 4-6 weeks after collection. Pre-soak seeds for 24 hours in cold water. Germination in about 20-56 days.
Teak *Tectona grandis*	All terrain	Jan-May (Jun-Nov)	Seeds, cuttings	Seeds stored for 12 months germinate easier. Soaked for 24-48 hours in warm water, changing the water frequently. Seeds from the same year should be subjected to alternate wetting and then drying for 24 hours each for 14 days. Collect seeds from trees over 20 years old. Germination in 10-90 days. The rooting time of cutting is 8-15 days. Able to survive fires.
Vaivai-kena-mē *Leucaena leucocephala*	Slopes, flats		Seeds	No seed pre-treatment is required.
Vaivai-ni vavalagi (raintree) *Samanea saman*	Gullies. riverbanks	Nov-May (Jul-Dec)	Seeds	No seed pre-treatment is required.
Vetiver grass *Vetiveria zizanioides*	Soil erosion areas	-	Cuttings	No seed pre-treatment is required.
Vutukana *Barringtonia edulis*	Slopes, flats	Year-round	Seeds	No seed pre-treatment is required.

Local & botanical name(s)	Suitability	Flowering (fruiting) months	Growing methods	Seed pre-treatment/sowing position/ germination time and notes
C. OTHERS				
Dakuamakadre *Agathis macrophylla (vitiensis)*	Slopes, ridges	Year-round	Cones/ seeds	Dry at room temperature for 1 day. 3-5 mm apart and 3-4 mm deep with 'pointed' end up and tip just emerging from the surface of soil. Germinates in 2-14 days.
Dakuasalusalu *Retrophyllum vitiense*	Slopes, ridges	Mar-Feb (Jun-Feb)	Cones/ seeds	Dry at room temperature for 1 day. Seed's base end is cut to speed up germination. Plant 3-5 mm deep with the cut end facing downwards in soil. Germination in 28-88 days.
Damanu *Calophyllum vitiense*	Flats, Slopes	Year-round	Seeds	Soak in water for 4 days. Remove the pulp off the seed and dry for 2-3 days at room temperature. Plant 3-4 mm apart and 3-4 mm deep in soil. Germination in 12 days
Kaudamu *Myristica castaneifolia*	Slopes, flats	Year-round	Seeds	Dry at room temperature for 2 weeks. Seed's hard coat is removed using a vice. Plant 3-5 mm apart in germination trays. Mahogany pod compost used as soil. Germination in 18-65 days.
Kaunicina *Canarium vitiense*	Slopes, flats	Year-round	Seeds	Dry at room temperature for 2-3 days. Seed's base end is cut to speed up germination. Plant 5mm apart and 3-4 mm deep with the cut-end facing downwards in soil. Germination in 87 days.
Kauvula *Endospermum macrophyllum*	Flats	Year-round	seeds	Leave seed in a bag for about 1 week until the pulp is gone. Rinse well and dry at room temperature for 2 days. Plant 5-7 mm apart and 3-4 mm deep in soil. Germination in 10 days.
Laubū *Garcinia myrifolia*	Creekbanks	Year-round	seeds	Soak in water for 4 days. remove the pulp off the seed, clean thoroughly and dry at room temperature for 3-4 days. Plant 5-7 mm apart and 3-4 mm deep in soil. Germination in 37 days.
Lolotagane *Ficus theophrastoides*	Gullies, riverbanks, creekbanks	Year-round	seeds	No seed pre-treatment is required.
Masiratu *Degeneria vitiensis*	Slopes, gullies	May-Jul (Sept-Dec)	seeds	Dry at room temperature for 2-3 days. Plant 5-7 mm apart and 3-4 mm deep in soil. Germination in 64-71 days.

Local & botanical name(s)	Suitability	Flowering (fruiting) months	Growing methods	Seed pre-treatment/sowing position/ germination time and notes
Coconut/Niu *Cocos nucifera*	All terrain	Year-round	seeds	No seed pre-treatment is required. not advisable to store seednuts longer than necessary. Germinates in 42-56 days.
Vesiwai *Pongamia pinnata*	Riverbanks, Creekbanks	Year-round	seeds	Soak in boiled water for 2 hours and dry for 24 hours at room temperature. Plant 5-7 mm apart and 3-4 mm deep with 'pointed' end up and tip just emerging from the surface of soil. Germination in 8 days.
Vuturakaraka *Barringtonia asiatica*	All terrain	Year-round	seeds	No seed pre-treatment is required.
Vutuwai *Barringtonia racemosa*	Gullies, riverbanks, creekbanks	Year-round	seeds	No seed pre-treatment is required.
Yaro *Premna protrusa*	Gullies, riverbanks, creekbanks	Year-round	seeds	No seed pre-treatment is required.
Yasi *Santalum yasi*	Slopes, flats, gullies	Oct-Feb (Jun-Aug)	seeds	Soak in water for 3 weeks or bury in sand for 10 days so that fruit pulp is easy to remove. Rinse well and dry for 3 days at room temperature. Plant 2-3 mm apart and covered with soil 3-4 mm deep in soil. Germination in 30-90 days.
Yasiwai *Syzygium fijiense*	Gullies, riverbanks, creekbanks	Jul-Feb (Nov-Mar)	seeds	No seed pre-treatment is required.

REFERENCES

D'Antonio C, Yelenik S, Trauernicht C (2018) PFX fact sheet-The grass-fire cycle. Pacific Fire Exchange-Joint fire science program. www.pacificfireexchange.org/research-publications/category/grass-fire-cycle-on-pacific-islands.

Department of Agriculture (2020) *Land use capability classification system-A Fiji guideline for the classification of land for agriculture*. Land Use Planning Section-Land Resource Planning & Development, Suva.

Naikatini AN (2009) *Monitoring comparative spatial and temporal variation in the land-birds of Vago-Savura Forest Reserve, a native lowland rainforest in South East Viti Levu, Fiji*. Master of Science in Environmental Studies (thesis). University of the South Pacific, Suva.

Trauernicht C, Kunz M (2019) Fuel Breaks and Fuels-Management Strategies for Pacific Island Grasslands and Savannas. Forestry and Natural Resources Management RM-22. College of Tropical Agriculture and Human Resources, University of Hawaii, Manoa.

Tuiwawa M, Buliruarua L, Dayal B (2010) How to Build a Simple, Low- Cost Community Nursery-A training manual for communities and field workers. The COWRIE Project. Institute of Applied Sciences, University of the South Pacific, Suva.

Tuiwawa M, Dayal B (2010) A guide to planting local tree species for forest restoration-A training manual for communities. The COWRIE Project. Institute of Applied Sciences, University of the South Pacific, Suva.

Useful Tropical Plants Database (2022) http://tropical.theferns.info. Accessed March 2022

Wildlife Conservation Society
Fiji Country Program
11 Ma'afu Street
Suva, Fiji
Telephone: +679 3315174
Email: infofiji@wcs.org