WWF

GUIDE

ZA

2019

A PRACTICAL GUIDE FOR COMMUNITY-RUN NURSERIES

Growing indigenous plants for restoration

© VICTORIA WILMAN

Caylot Zide, erica specialist at Kirstenbosch National Botanical Garden, with *Erica irregularis* seedings.

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Citation: Wilman, V (2019) A practical guide for community-run nurseries: Growing indigenous plants for restoration. WWF South Africa, Cape Town
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Design and layout: Design for development **Printer:** Hansa print **Printed on:** Galerie Art, FSC certified

WWF is one of the world's largest and most experienced independent conservation organisations with over 6 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.
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South African National Biodiversity Institute

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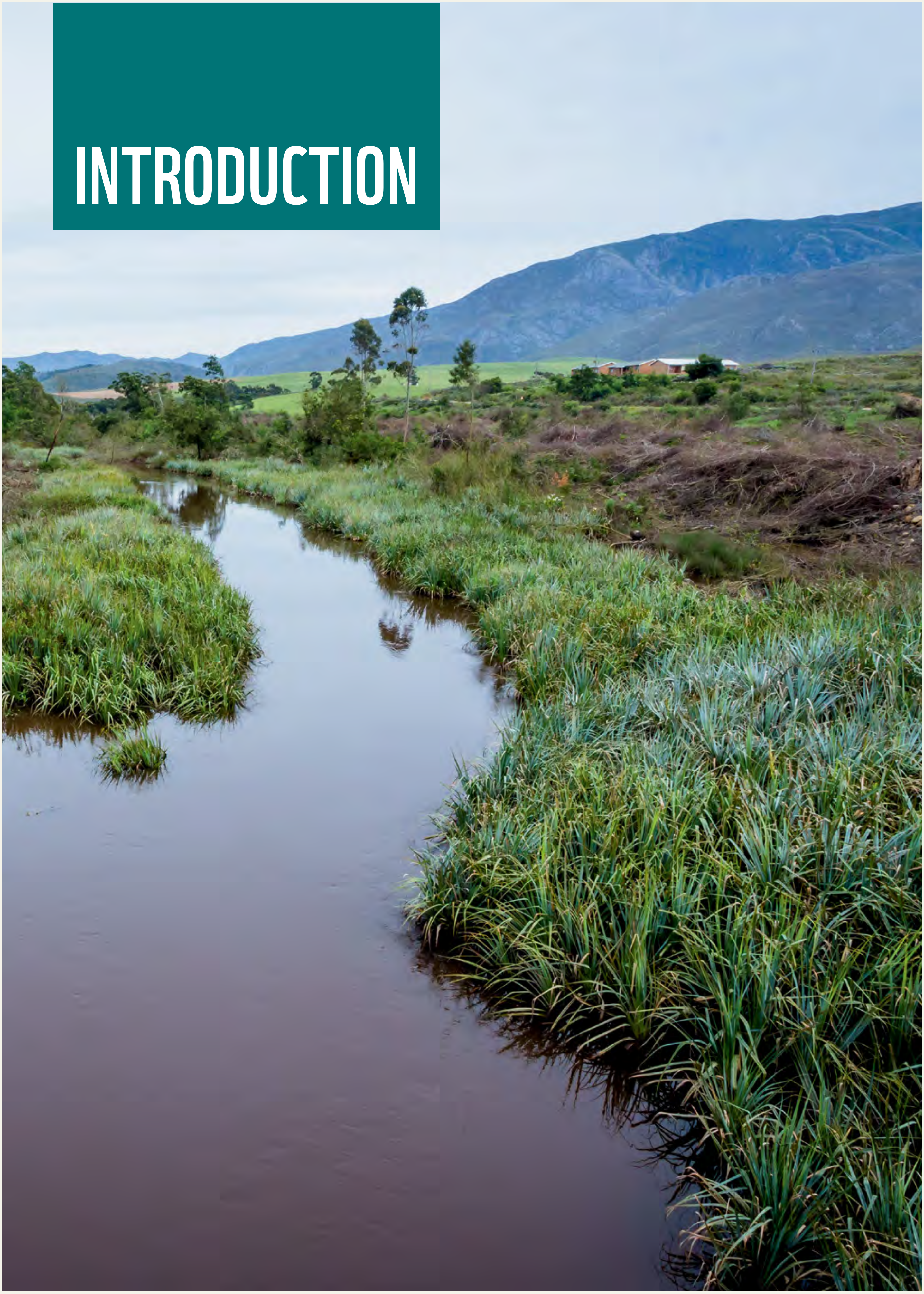
NEDBANK

Nedbank is proud to fund the production of this guide as part of its support for WWF as we work together to safeguard South Africa's water source areas, improve rural livelihoods and promote land stewardship. WWF and Nedbank have been working together in various forms for almost 30 years – a long-term NGO/business partnership that continues to evolve and innovate in finding solutions to complex sustainability challenges in South Africa.

CONTENTS

INTRODUCTION



The reed-like plants along this river is known as palmiet, an indigenous wetland ‘superplant’ that prevents flooding and stops sediment from being swept downstream.

A SHARED WATER FUTURE

Only 10% of South Africa's land is responsible for over half of its water supply. That is why we must manage and protect these areas, known as water source areas, in such a way that they can keep providing water for future generations.

WWF believes the best way to achieve this is to establish water source area community-public-private partnerships. These partnerships need to:

- **ENABLE** coordinated governance and effective action on the ground to better manage our water source areas
- **CREATE** opportunities for communities in the water source areas as well as shared benefits for communities living downstream
- **STOP** and prevent degradation of land and water resources in the water source area and ensure sustainable development

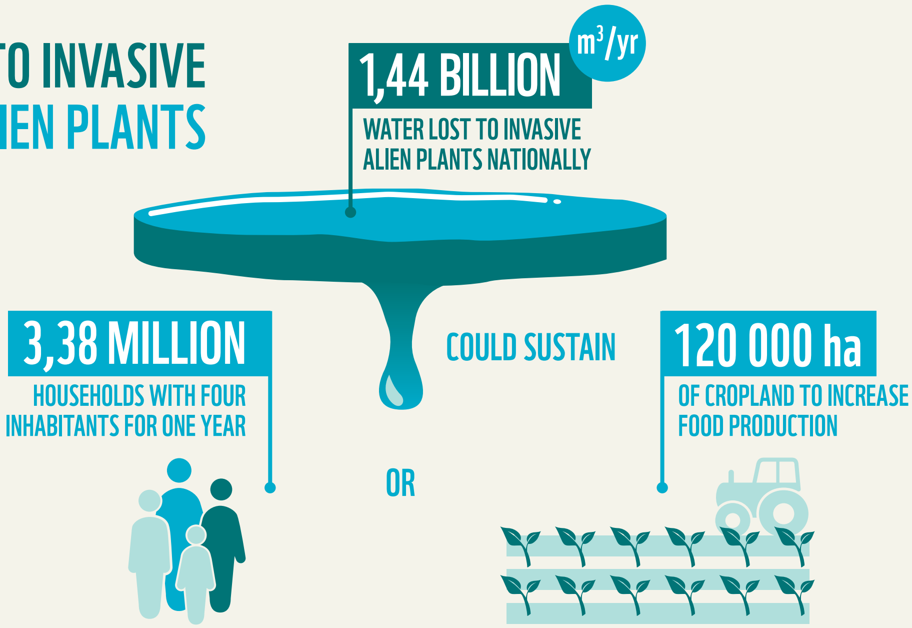
WHAT IS THE PROBLEM?

South Africa is a naturally water scarce country. That means there is not enough water in the country to meet everybody's water needs. Almost all the reliable water yields from our natural landscapes (catchments) have already been allocated. The catchments are threatened by inappropriate land-use practices, the climate crisis and wildfires, among other things. To date, 50% of South Africa's wetlands have already been lost, 84% of our freshwater systems are threatened and of those, 44% are critically threatened.

In the Western Cape, a major threat to water yields from many of our water source areas is the ever-spreading problem of alien invasive plants. These are plants that did not naturally occur in South Africa, but which were introduced to the country. Most were originally introduced for a purpose, such as the pulp and paper they can supply because they grow so quickly. But if these plants are not in well-managed plantations, their negative impacts can far outweigh their benefits. With no natural predators (insects or animals) to keep their numbers in check, they spread quickly, often crowding out the indigenous vegetation. They also use more water as they grow quicker and larger than the other plants in the surrounding area.

TO DATE, 50% OF SOUTH AFRICA'S WETLANDS HAVE ALREADY BEEN LOST

WATER LOST TO INVASIVE ALIEN PLANTS



WHAT IS THE NEED?

There are many alien clearing initiatives on the go across the country, especially around vital river areas where most water is lost, but this is just one part of the solution. Once infested areas have been cleared, they need to be maintained to keep the alien plants' seeds from sprouting again. Ultimately, the areas need to be restored to their natural state, with naturally occurring plants – especially around river banks.

Restoration, the practice of fixing or restoring damaged or degraded areas in the environment, plays an important role in the invasive alien plant clearing process. One can restore an area **passively** or **actively** to suppress the regrowth of invasive alien plants. If the natural vegetation is restored, it also reduces the ongoing cost of continuously clearing alien vegetation and maintaining the area. Restoration enables the environment to return to a state where everything functions as it should, to benefit people, animals and the planet.

WHAT IS THE OPPORTUNITY?

An important point is that one should use locally occurring indigenous plants when it comes to active restoration (ie. planting plants back into the veld). This is where the opportunity lies.

Restoration not only **stops** further degradation of land and water resources, it also **creates** opportunities for those living in the water source areas to have a sustainable livelihood. This is compatible with a healthy, well-managed environment and contributes to healthy communities.

Often, the cleared sites that require active restoration are in remote, hard-to-reach areas, far away from cities or towns. In these areas there are usually very few jobs or opportunities to make a living for the people in nearby villages or towns.

Operating a community-owned nursery that stocks plants that can be used to restore the veld can be labour intensive. But this is a good thing, because it can provide jobs and create livelihood opportunities for members from the local community.

However, to operate a nursery, one has to know the indigenous plants and how to propagate them, and how to set up and manage a nursery.

This 'how to' guide provides an overview of the skills and knowledge needed to run a community-based nursery to grow indigenous plants that can be planted back into nature. The idea is that it should serve as a reference to which those employed by community nurseries can continually refer.

WHAT IS WWF'S CONTRIBUTION?

WWF South Africa has developed this practical guide because it supports the development of the green economy in South Africa's water source areas. We work with our partners in water source areas to help small and medium-sized enterprises (SMMEs) to restore catchments and create a better life for people and nature.

In the Boland Water Source Area outside Cape Town, WWF has invested in the Genadendal community nursery near Greyton. The aim of this community-run nursery is to rehabilitate and restore tributaries of the Sonderend River (Riviersonderend), which is a major tributary of the Breede River in this water source area.

In the Genadendal nursery, 15 people have been employed and trained to contribute to the healthy restoration of the catchment. At the same time, they are earning a living to support their families.

ABOUT THIS GUIDE

This guide is organised into three sections: Introduction; General principles of propagation and Propagation techniques. Photographs, icons and drawings are used to clarify concepts. We have also included a glossary of terms and a list of useful resources that community nursery owners and staff can consult when growing plants for restoration.

RESTORATION

Ecological restoration is the practice of fixing, renewing and restoring degraded or damaged ecosystems and habitats in the environment by human intervention and action.

WHY RESTORE?

Intact, functioning natural ecosystems, which are called our 'natural infrastructure', provide society with a number of goods and services, such as:

CLEAN AIR	Ecosystems produce oxygen and also purify and detoxify the air
CLEAN WATER	Ecosystems provide us with clean water and store and cycle fresh water
CLIMATE	Ecosystems regulate the climate
HEALTHY SOIL	Ecosystems form topsoil and prevent erosion and flood damage
RAW MATERIALS	Ecosystems produce raw materials, foods and medicines

Most of these ecosystem goods and services cannot be replaced by human technology, at any cost. But when they function properly, these systems reduce the need for built infrastructure, such as filtration plants and dams.

As explained on page 3, the need to tackle the threat of invasive alien plants has been recognised for many years. In 1995, the government established the Working for Water Programme to combat the problem. But it is only more recently that we started to realise what an important role restoration can and should play in the process.

Restoration will ensure that our natural infrastructure can keep producing these ecosystem goods and services for us. By planting back lost or endangered species, we can prevent extinction, maintain biodiversity, reverse the loss of species and help restore the way the natural environment functions.

Restoration can be either passive or active

Passive restoration

Passive restoration means alien plants may have been cleared or activities damaging the ecosystem may have been stopped, and the area is left to recover naturally. The causes of degradation are removed from the system and the system is allowed to repair itself over time.

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Active restoration

Active restoration means there is a need for further actions after the clearing was done or damaging activities were stopped. The area will not be able to recover naturally, it will need some help. For example, species can be reintroduced to the area by planting them back or sowing seeds.

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COMMUNITY NURSERIES

When active restoration is required, community-based nurseries can be set up to propagate and stock the plants that will be required for replanting in the veld.

The plants that will be used for replanting must naturally occur in the area. This is very important for several reasons:

- Plants which naturally occur in an area are well adapted or suited to the local conditions. This increases the survival rate and benefits provided by these plants.
- By introducing new species to an area – i.e. species that do not naturally occur there – one can unintentionally introduce a new threat to the environment. The new species or plant may outcompete or dominate the local plants and in this way unbalance the ecosystem.
- Collecting seeds or plants from the local area or catchment to grow on site in the nursery reduces transport costs and keeps plant genetics local.

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Restoration through community-run nurseries creates job opportunities.

SELECTING A SITE FOR THE NURSERY

The site for the nursery must be carefully selected with great attention to detail. Here are some guidelines:

- Know which species you are going to propagate.
- Choose a site close to the restoration site.
- Choose a site that will offer protection from drying winds.
- Plants should be grown where there is a favourable microclimate.
- The site should be relatively level with a very slight slope.
- There must be good drainage.
- There should be good road access for deliveries.
- The site must be close to a clean water source and close to a source of electricity.
- The site must be large enough to hold the number of plants necessary and for potential expansion.

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A collection of indigenous plants grown for restoration.

WHAT DO YOU NEED TO SET UP A NURSERY?

In addition to appropriate areas for storage of seed, fungicides and insecticides, as well as staff facilities such as work areas, rest areas, a kitchen and ablutions, you will need the following:

© KAMOGELO MODIMOLA

A seed house for germinating seeds and some hardy cuttings.

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A shade house for hardening off seedlings after transplanting them into bags – it should provide 20–40% shade cover.

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An open growing area for growing and hardening plants before transporting to the field.

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An added option is a cutting house or greenhouse for propagating soft cuttings.

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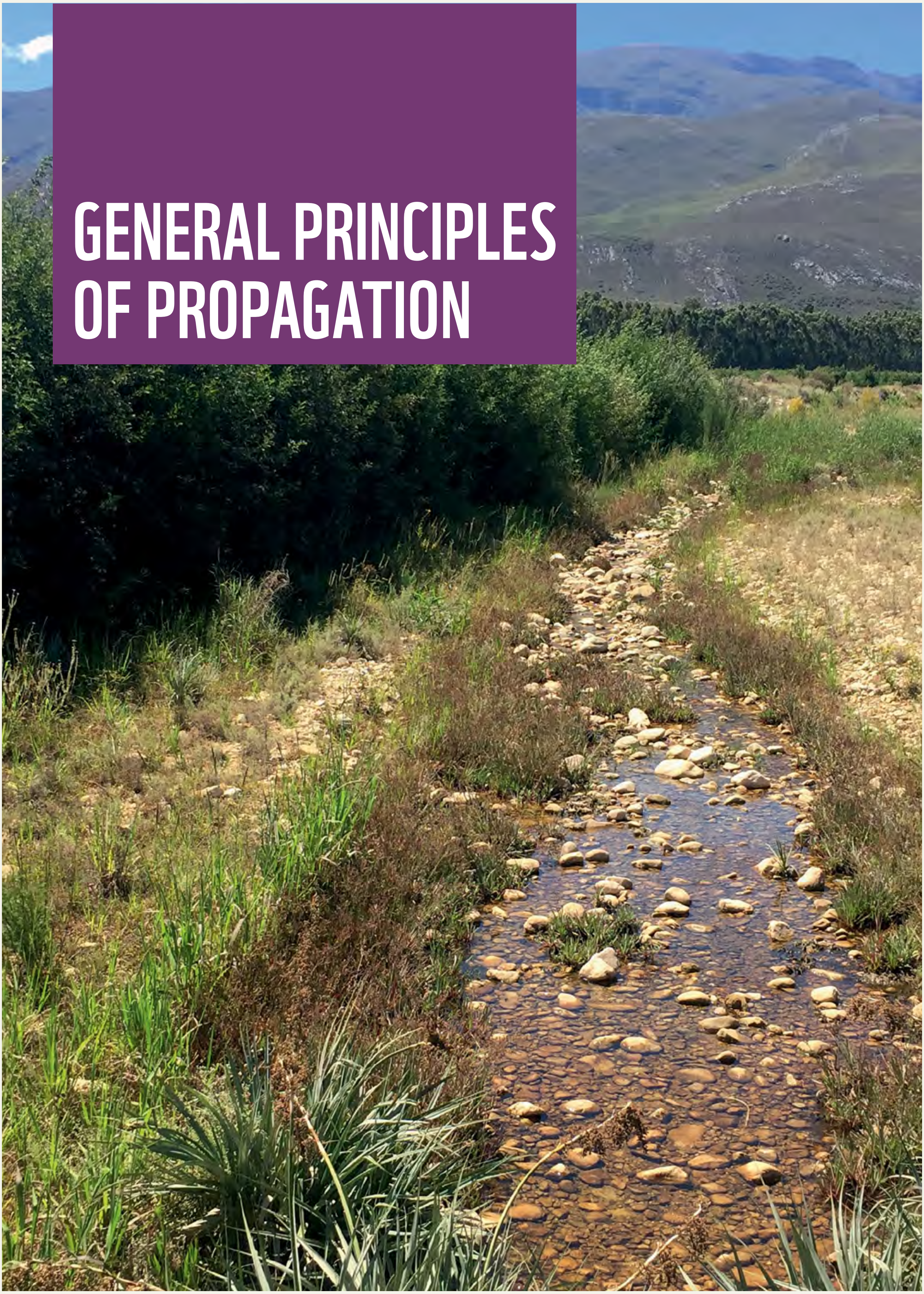
A work area for propagating plants, with a nearby water point.

© KAMOGELO MODIMOLA

A potting shed for potting plants with storage areas for equipment.

GENERAL PRINCIPLES OF PROPAGATION



As a tributary of the Riviersonderend, the Meul River is an example of a river that has undergone restoration with indigenous plants from the nearby Genadendal nursery.

UNDERSTANDING PROPAGATION

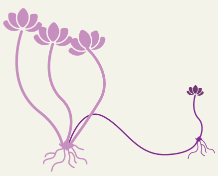
Propagation means to grow new plants. It is the science or art of starting new plants and increasing their numbers.

HOW ARE PLANTS PROPAGATED?

Plants can be propagated in two ways: through sexual or asexual (vegetative) propagation.

Sexual propagation	Asexual or vegetative propagation
Reproducing plants through seeds or spores.	Reproducing plants through vegetative cells, tissues or organs, e.g. cuttings or leaves.
 © KAMOGELO MODIMOLA	 © KAMOGELO MODIMOLA

Plants propagate naturally by seeds and spores in nature. Less often, they can propagate asexually (vegetatively) by means of ramets, rhizomes, natural layering and offsets.

	RAMET	A new plant derived by vegetative reproduction from a single parent plant and often (at least initially) remaining physically connected with it.
	RHIZOME	A modified underground plant stem that sends out roots and shoots from its nodes, from which a new plant grows.
	LAYERING AND OFFSETS	A horizontal branch from the base of a plant that grows roots and produces a new plant.

WHICH PROPAGATION APPROACH SHOULD A NURSERY USE?

Nurseries can use both of these approaches – sexual and vegetative propagation. Each has its own advantages:

Propagating from seeds (sexual propagation)	Propagating from cuttings (vegetative propagation)
Relies on seed production by the 'mother' plant, according to the season	Can be done all year round
Can be done without specialised equipment and greenhouses	May require a greenhouse
Results in genetically more varied plants, which are often stronger	Results in plant replicas or clones

PROPAGATING FROM SEEDS

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© VICTORIA WILMAN

© VICTORIA WILMAN

PROPAGATING FROM CUTTINGS

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TEN PRINCIPLES OF PROPAGATION

Propagation of plants for restoration need not be difficult or daunting if the basic principles are followed.

1. Collect seeds or cuttings from **healthy plants** from an area close to the restoration project.
2. Study the **plant species in the wild** to understand which propagation technique should be used.
3. Using the **correct propagation technique** for a species will allow the seeds to germinate or the cuttings to root more easily, increasing the young plants' chances of survival.
4. Choose the **medium** for propagation according to the needs of the species – the medium or soil must be clean and well drained but able to hold enough moisture to start the germination or rooting process.
5. Filling **potting** bags to the brim and placing plants of similar ages and water requirements together can save time and labour.
6. Choosing **containers and labelling** plants with the plant name, propagator details and date help with ongoing management.
7. The correct **placement** of seeds or cuttings at the various stages of growth is vital.
8. Plants in the nursery should always be **well maintained and kept weed free.**
9. Proper **hygiene** throughout the nursery is essential.
10. The correct **watering regime** must be maintained throughout the propagation process.

By following these principles, the nursery can maintain quality and plant health from the start of the process – from when the seeds or cuttings are collected – through all the stages of cultivation until plants are replanted in the veld. This will bring about a higher success rate for restoration projects. Each of the principles is discussed in more detail on pages 14 to 23.

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1. HEALTHY PLANTS

Collect seeds or cuttings from healthy plants from an area close to the restoration project.

Propagation material (seeds or cuttings) must be collected from a healthy natural habitat close to the area that will be rehabilitated. If seeds or cuttings are collected from nature reserves or conservation areas, the correct permits must be obtained from authorities before starting with collection.

Collecting seeds

When collecting seeds from wild plant populations, not **more than 20%** of the available seed should be collected at one time from each plant. This will ensure the survival of the natural plant population.

Seeds should be collected from **different plants** in the area to ensure a good gene pool in the rehabilitated populations.

Viable healthy seeds should be collected at the **optimum stage of development**, usually when the seeds are dropping naturally. Seeds must be stored correctly in a cool, dry area until sowing.

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Collecting cuttings

Sharp, sterilised secateurs should be used when working with plant material.

Ideally, cuttings should be collected in the **cool, early mornings** from plants that are **disease and pest free**.

Freshly cut material must immediately be placed in **plastic bags** containing a **tiny amount of water** to keep the cuttings moist.

Individual cuttings should be made and placed in the greenhouse as **soon as possible** after collection

© VICTORIA WILMAN

2. WILD PLANTS

Study the plant species in the wild to understand which propagation technique should be used.

Propagation and cultivation will be more successful if one can mimic the conditions in which the plant is growing in the wild. This can include the soil type in which the plant is growing, the climate (temperature and rainfall) and how the plant reproduces in the wild (for example, do the seeds require fire to germinate?). If possible, one should do as much research as possible on the species that will be propagated. If there is no information available, a process of trial and error will be necessary.

BE SURE THE RIGHT SPECIES ARE GROWN AND PLANTED BACK IN NATURE

Tip:

You can make a list of the species occurring near the restoration site.

How are plants named?

Knowing the basic principles of plant naming helps to identify different species and work out how best to propagate them.

It is important to use the correct scientific plant names when growing for restoration to be sure that the right species are cultivated and planted back in nature. When running a nursery, one cannot rely on common plant names because the same common name could be used for different species.

Plants that are similar are part of a **family**. Within each family are a number of **genera** ('genera' is the plural of 'genus'). Within each **genus** are a number of **species**. Let's use the sugarbush protea as an example:

Family: Proteaceae

Genus: *Protea*

Species: *repens*

Scientific plant names consist of two parts, the **genus** and the **species**, e.g. *Protea repens*, and it is written in italics (the family name is not italicised). The genus name is written with a capital letter and the species name with a small letter.

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Brabejum stellatifolium
(Family Proteaceae)

© ALICE NOTTEN

Pelargonium peltatum
(Family Geraniaceae)

© ALICE NOTTEN

Erica abietina
(Family Ericaceae)

© ALICE NOTTEN

Cyperus textilis
(Family Cyperaceae)

© VICTORIA WILMAN

Berzelia abrotanoides
(Family Bruniaceae)

© ALICE NOTTEN

Selago canescens
(Family Scrophulariaceae)

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Prionium serratum
(Family Thurniaceae)

© ALICE NOTTEN

Leucospermum cuneiforme
(Family Proteaceae)

3. PROPAGATION TECHNIQUE

Using the correct propagation technique for a species will allow the seeds to germinate or the cuttings to root more easily, increasing the young plants' chances of survival.

It is useful to know how best to propagate a plant. Some plants do better propagated from seed while others can be propagated very easily from cuttings. Some plants cannot survive from cuttings or do not germinate easily from seeds. The propagation method most suitable for a particular plant can be learned through researching the species or conducting trials. You can use the following as a rule of thumb:

Plant	Grow from...
Trees	Seed
Grasses, bulbs and restios	Seed or division
Groundcovers, herbaceous perennials	Seed or softwood and tip cuttings
Shrubs and climbers	Semi-hardwood stem cuttings
Succulents	Big cuttings, placed directly into bags of potting medium

Seeds may need some kind of treatment, such as smoke, scarification or soaking in hot water before sowing and may need to be sown in a certain way. For example, tree seeds need to be sown under soil in deep seed trays or directly into plant bags where they have space for their roots to grow down, while tiny seeds should be sown close to the surface as the seedlings will struggle to reach above the soil if sown too deep.

There are also many different types of cuttings that can be made, including hardwood, semi-hardwood and softwood, heel cuttings, stem cuttings or tip cuttings. It saves time if you know which technique to use and how to do it. Timing is also important – one should know when to collect cuttings and when best to sow seed as this will affect the rooting and germination success. These propagation techniques are discussed in more detail in the next section.

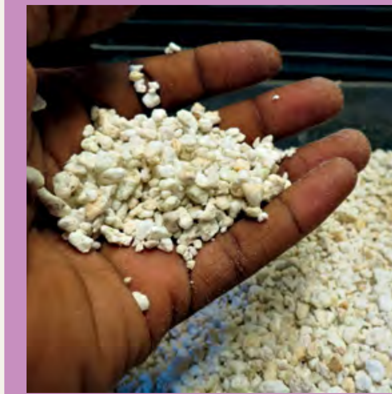
4. MEDIUM

Choose the medium for propagation according to the needs of the species – the medium or soil must be clean and well drained but able to hold enough moisture to start the germination or rooting process.

The medium or soil is critical to the success of plant propagation. Potting media are not the same as propagation media – potting media hold more nutrients and contain compost and organic material to sustain the plant for a long period.

The ideal propagation medium should supply the correct balance of air and water for the developing root system. It should be sufficiently firm and dense to hold the seeds and cuttings in place during rooting or germination. The mixture should be easy to wet and must retain enough moisture, but must also be sufficiently porous to allow excess water to drain away and oxygen to reach the roots. The medium should be free of weed seeds and harmful organisms.

The exact characteristics of the medium will vary according to the species you want to propagate. Soil-less media are recommended for growing large quantities of seeds and cuttings, especially when it is not possible to sterilise the soil. It is best to use a medium low in nutrients for propagation to avoid problems with algal and weed growth. Some common components of propagation media include pine bark, vermiculite, perlite and sand. These can be used separately or mixed together to make a seedling or cutting mix. A mix of one part fine bark and one part coarse sand is relatively inexpensive and makes a good medium.

Type of medium	Milled bark	Vermiculite	Sand	Perlite
	 © KAMOGELO MODIMOLA	 © KAMOGELO MODIMOLA	 © KAMOGELO MODIMOLA	 © KAMOGELO MODIMOLA
What is it made of?	Shredded pine bark (6 mm) sieved finer for propagation	Vermiculite is a mineral that looks like mica. It contains no soil.	Sand consists of small, weathered rock particles 0,05 to 2 mm in diameter.	Perlite is a grey-white volcanic glass that expands and forms sterile sponge-like kernels when heated.
What are its qualities?	Milled bark absorbs and retains moisture well. At the same time it is coarse enough to allow rapid drainage of excess water. It is acidic in nature.	Vermiculite does not dissolve in water. It provides lots of air space if not pressed down. It is able to hold large quantities of water and nutrients.	Sand contains no nutrients and has a near neutral pH. Quartz sand is generally used for propagation. It should not be too fine. It has excellent drainage and can stimulate rooting in cuttings because of its abrasiveness. In propagation media it is often used in combination with organic materials and is added to improve drainage.	The sterile perlite kernels are very light and porous. Perlite has a neutral pH and can hold three to four times its weight in water yet will not become soggy for a long period.
Why add it to a mixture?	Milled bark lightens a mixture, increases air spaces and drainage while providing moisture-holding capacity.	When handled gently, it increases the water-holding capacity and aeration and lightens the mixture without adding organic nutrients.	Coarse river sand adds air spaces to a mix, drains rapidly and stimulates rooting in cuttings.	Perlite increases aeration and improves drainage. It is usually used in combination with milled bark.

5. POTTING

Filling potting bags to the brim and placing plants of similar ages and water requirements together can save time and labour.

At this stage, seedlings and/or rooted cuttings will be planted into plug trays, potting bags or pots filled to the brim with potting soil. Potting soil can be obtained ready mixed from various suppliers, or created at the nursery by mixing compost or milled bark with sand. Other ingredients may be added to maintain a specific pH. Slow-release fertilisers can also be included. The potting soil mix should hold moisture but must also drain well. Recommended potting soil mixes are given below:

Mixture	Components
General mix 1	6 parts well-decomposed compost 2 parts well-aged milled bark (5–12 mm) 1 part gritty river sand
General mix 2	4 parts well-decomposed compost 3 parts well-aged milled bark (5–12mm) 1 part gritty river sand
Fynbos mix	7 parts well-aged milled bark (5–12mm) 3 parts coarse washed river sand
Bulbs/succulents and open benches	4 parts general mix 2 parts well-aged milled bark (5–12mm) 2 parts coarse washed river sand

Seedlings are transplanted after they have grown their first true leaves. They must be carefully teased out of the seed trays, separated from other seedlings, and placed with all their roots covered into plug trays or potting bags, depending on the size of the seedlings. It is better to place very small seedlings into plug trays first so that they can become more established before transplanting them into bags. Be sure not to damage the roots in the potting process and place the plant at a similar depth in the soil to where it was in its propagation stage. Give the newly planted seedlings a good watering with a very fine rose watering can.

Seed leaves and true leaves

When a seed germinates, the first single leaf or pair of leaves to emerge above the soil are called the seed leaves because they are part of the seed's embryo. They provide stored nutrients to the seedling until its true leaves grow. When the true leaves emerge, the plant can begin to photosynthesise. That means the plant is able to make its own food.

Rooted cuttings can be planted into bags or pots when they are well rooted and you can see a few roots poking out of the holes on the underside of the plug trays. The same principle applies as above, except that cuttings should be carefully removed from the plug trays by pushing them up from below rather than pulling them from above. They can then be planted, propagation medium and all, into their new containers.

Containers should be filled right to the top with potting soil; once they are watered, the soil will sink slightly. Plastic plant bags, especially, should be filled to the brim. If the soil is too low in the bag, the plastic edges fold over, preventing the plant from getting water.

Plants of the same age, species, bag size and watering requirements should be placed together in the shady hardening-off area of the nursery for ease of care.

6. CONTAINERS AND LABELLING

Choosing containers and labelling plants with the plant name, propagator details and date helps with ongoing management.

Plants can be propagated and grown in various containers. They can even be grown in open beds. White plastic labels can be used to label plants, and it is best to write on them with a 6B pencil. After planting, plants should be labelled with the following:

1. Name of the plant
2. Date of propagation and potting
3. Name of the propagator (person)
4. Name of the restoration project or restoration area
5. Origin of the plant (where the seeds were harvested)

Tip:

Use a 6B pencil to write on labels – it lasts longer and does not wash off.

Whichever container you choose to grow your plants in (see table below), it should always be **clean and sterilised before planting**. Recommended disinfectants are Terminator or Sporekill (brand names) – mix 1 mℓ to a litre of water. The active ingredient in these disinfectants is didecyl dimethyl ammonium chloride.

Shallow or deep plastic seed trays with drainage holes

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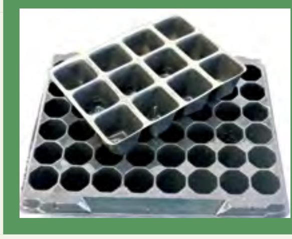
Used for seed propagation.

Deep trays are used for larger plants, bulbs and plants with deep root structures (e.g. trees).

Seeds can be sown in open sowing beds or seed trays.

Plug trays or multi-trays



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Used for larger seeds that may not require an additional potting stage.

Also used for cutting propagation and second potting of small seedlings from seed trays.

Come in different sizes and can have cavities of 6, 20, 90, 105 and 128 or more.

Seedlings or rooted cuttings can be easily removed from the tray for potting without damaging the roots.

Smaller plants can be grown and transported more cheaply in these trays.

Some trays have separate little plug pots that rest in wire frames so each pot can be removed individually. This is very useful for restoration.

Biodegradable pots

© GROWRITE

Jiffy peat pots from Growrite are an alternative to plastic pots and are 100% biodegradable, compostable and approved for organic production.

During transplanting, the rooted plant and the peat pot can be planted together, saving time and labour and reducing any stress to the plant that may be caused by disturbing the root zone.

Proteaceae and other similar plants with sensitive root systems benefit from propagation in peat pots.

Pots and planting bags

© VICTORIA WILMAN

Seedlings and rooted cuttings are transplanted and grown on in pots or plastic bags of various sizes.

Planting bags are cheaper but less likely to be reused while plastic pots are more durable and don't have the problem of tearing, breaking and folding over.

If possible, once planted, the pots can be placed in crates for easy counting and transporting.

7. PLACEMENT

The correct placement of seeds or cuttings at the various stages of growth is vital.

During the different stages of propagating and growing plants, they need to be kept in different areas or structures in the nursery at different times. They will also have differing watering regimes at the different stages of propagation. The different areas or facilities and their uses were explained on pages 8 and 9. The table below contains guidelines on where plants should be placed during each growing stage.

Activity	Stages for seed propagation	Stages for cutting propagation
Collection	**Place:** In veld **Time:** When plants are seeding	**Place:** In veld **Time:** All year round, but ideal after flowering when new shoots show
Storage	**Place:** Seed store	**Place:** Cutting material can be stored in the fridge for a very short period after collection and before planting
Propagation	**Place:** Seed house **Time:** Until two true leaves have grown	**Place:** Greenhouse (soft cuttings) **Place:** Seed house or shade house (hard cuttings) **Time:** Until a substantial root ball has formed
Potting	**Place:** Potting shed **Time:** Time taken to pot	**Place:** Potting shed **Time:** Time taken to pot
Hardening-off	**Place:** Shade house **Time:** Minimum of 10 days for some species, 4 weeks ideal for a proper root ball to establish	**Place:** Shade house **Time:** Minimum of 10 days depending on species
Hardening-off phase 2 / Growing on	**Place:** Open growing area (with sunshine) **Time:** Until ready for transplanting in the veld. May require repotting if necessary	**Place:** Open growing area (with sunshine) **Time:** Until ready for transplanting in the veld. May require repotting if necessary

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Seed trays and open sowing beds.

8. MAINTENANCE AND CULTIVATION

Plants in the nursery should always be well maintained and kept weed free.

When growing plants, right from the propagation stage through to the hardening-off and growing-on phase of plant production, the plants should be well maintained and kept healthy and weed free. This is an important part of nursery management and is vital to the survival of one's plants.

The nursery and its surrounds should also be kept clean and weeds should not be allowed to take root and spread. They should certainly not be allowed to reach seeding stage.

During cutting propagation, the cuttings should be monitored and any dead plants removed from the trays and cutting beds. Dead plants left in the trays can cause disease and fungal problems for the healthy cuttings. Any dead leaves that have dropped should be removed so that the cutting beds are as clean and sterile as possible.

Once cuttings are rooted, they can be removed from the cutting beds and placed in the hardening-off area before potting. They can be fed with a liquid fertiliser to help them along. The propagation medium does not contain any nutrients, so feeding at this stage between potting is beneficial.

Tip:

Remove dead plants from the trays because they can cause disease and fungal problems for the healthy cuttings.

Plants that are planted in pots and bags quickly use up any nutrients that were in the potting soil. Nutrients need to be replenished by adding fertiliser. Seedlings in plug trays and those plants planted in pots would benefit from a slow-release organic fertiliser in the potting soil that can slowly release the required nutrients over a period of six months to a year, depending on the fertiliser.

However, these fertilisers need to be used carefully as some fynbos species can react badly to an excess of fertiliser that may be released during hot weather conditions. Talbourne organic 5:1:5 fertiliser is used with good results on fynbos species and only a small pinch is needed per plant twice a year. Alternatively, an organic liquid fertiliser can be used, such as Seagro or Nitrosol, alternated every second week.

© ANTHONY HITCHCOCK

Using crates allows for easy stocktake and transporting.

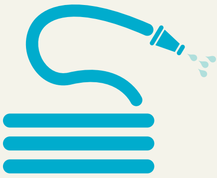
9. HYGIENE

Proper hygiene throughout the nursery is essential.

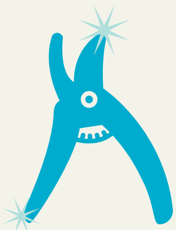
Two of the most important factors of plant propagation are sanitation and hygiene. Many plants are lost due to various pathogens, diseases and insect pests because sanitation is not well managed.

Everything in the nursery should be clean or sterilised, from the beginning of the process to the end.

- Propagation facilities (places where cuttings are made, seeds are treated, etc.) should be separate from storage areas and areas where the propagation or potting media are mixed.

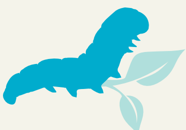


- Tables, equipment, greenhouse benches and floors should be regularly washed down and disinfected with bleach. Vinegar is an inexpensive alternative and just as effective. Other recommendations for disinfectants are Terminator or Sporekill (brand names) – these can be mixed at 1 mℓ per litre of water. The active ingredient of these disinfectants is didecyl dimethyl ammonium chloride.
- Irrigation water should ideally be chlorinated to kill algae and pathogens.
- Propagation mix must be mixed on a clean surface and stored in clean bins.



- Mist propagating and growing areas, such as greenhouses, seed houses and shade houses, should be kept clean. Diseased or dead plant debris and fallen leaves should be removed daily. Any weeds should be removed before they set seed. The areas immediately around greenhouses should also be kept free of weeds and pathogens.
- Propagation houses and benches should be kept free of algae on damp floors and benches.
- Tools, especially secateurs, must be kept clean and sharp and regularly dipped in a sterilising agent before cutting plant material.
- Cutting material that is collected must be placed in clean plastic bags (sterilised).

- Propagation trays must be washed and sterilised before use – mix a Terminator solution in a big drum and dip the trays into it before using.
- After the trays have been filled up with growing medium, a disinfectant solution can be sprinkled over the medium with a watering can to minimise the chances of infection.



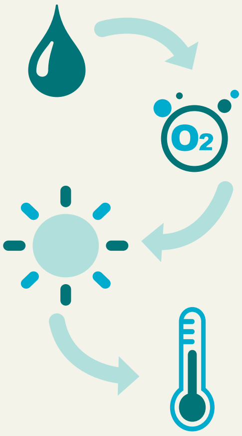
- Cuttings that have been rooting for a while should be removed and assessed; if calluses have developed, even though no roots have formed yet, they should be retreated, placed in a fresh rooting medium and replaced in the greenhouse.
- High humidity, abundant moisture and warm temperatures can stimulate the rapid development of pathogens and insects. Humidity and moisture should be actively managed for rapid rooting without plant losses. Regular monitoring for pests and diseases is essential. Regular monitoring will also identify any problems with the irrigation system where cuttings or seedlings are not being irrigated.

- Any plants that have died during the propagation or growing stage should be removed. If they have died of disease, viruses or pest infections, they must be burned and not put with composting material that will be reused.

Keeping a clean growing environment will reduce seedling losses. It can also reduce the need for using insecticides and fungicides.

10. WATERING REGIME

The correct watering regime must be maintained throughout the propagation process.



There are four main environmental factors that affect germination, cutting production and plant growth. These are **water, oxygen, light** and **temperature**. Plants need the correct balance of water to maintain growth so that they do not dry out or become waterlogged, which can be equally damaging.

Watering during propagation

After sowing seeds, making cuttings or potting up, the trays and plant bags should be watered with a fine rose watering can, taking care to spread the water evenly over the soil so as not to wash out the seeds.

In seed propagation, the first part of the germination process is where the seed absorbs water. There should be enough water continuously available in the medium for the germinating seed. If the propagation medium is allowed to dry out once the germination process has begun, the embryo or baby plant may die. Overwatering can also be a problem, so ideally seedling trays should be watered daily and kept moist, but the surface should be allowed to dry out slightly between waterings.

Cuttings in a greenhouse need to have a balance of air and water at the rooting zone as well as humidity around the leaves. Humidity of 70–80% is ideal and prevents water loss from transpiration, especially for softwood and leafy cuttings. Softwood cuttings need an intermittent misting system that can be programmed to mist many times a day. Good air circulation around the cuttings is also essential. However, the cutting medium should not be allowed to become waterlogged.

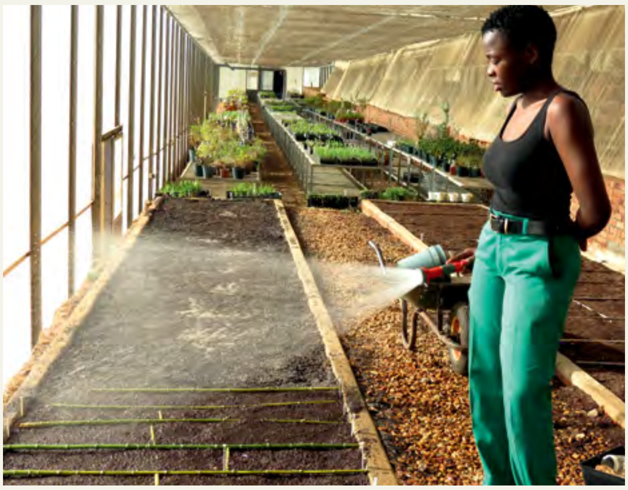
Watering seedlings and young plants

Young seedlings and newly rooted cuttings require regular watering as they are susceptible to drying out, especially during the summer months. They should be watered daily.

Watering established plants in pots

Established plants in pots or bags should be watered based on daily monitoring of the potting medium in their containers. They may only need watering every 2–4 days on average, but the exact frequency depends on the size of the bags, root development, the size of the plant and the duration of watering. The soil in the bags should always be slightly moist and never completely dry.

An irrigation system on a timer that waters automatically would be ideal. However, even with an automated system, regular monitoring of the water shadow and sprinkler nozzles is essential to make sure that all the plants are receiving water and to prevent plant losses. It is important to note that overwatering can be just as damaging as underwatering and can result in waterlogging and suffocation of the plants.



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Seeds should be watered frequently and kept moist, but the surface should be allowed to dry out slightly between watering.

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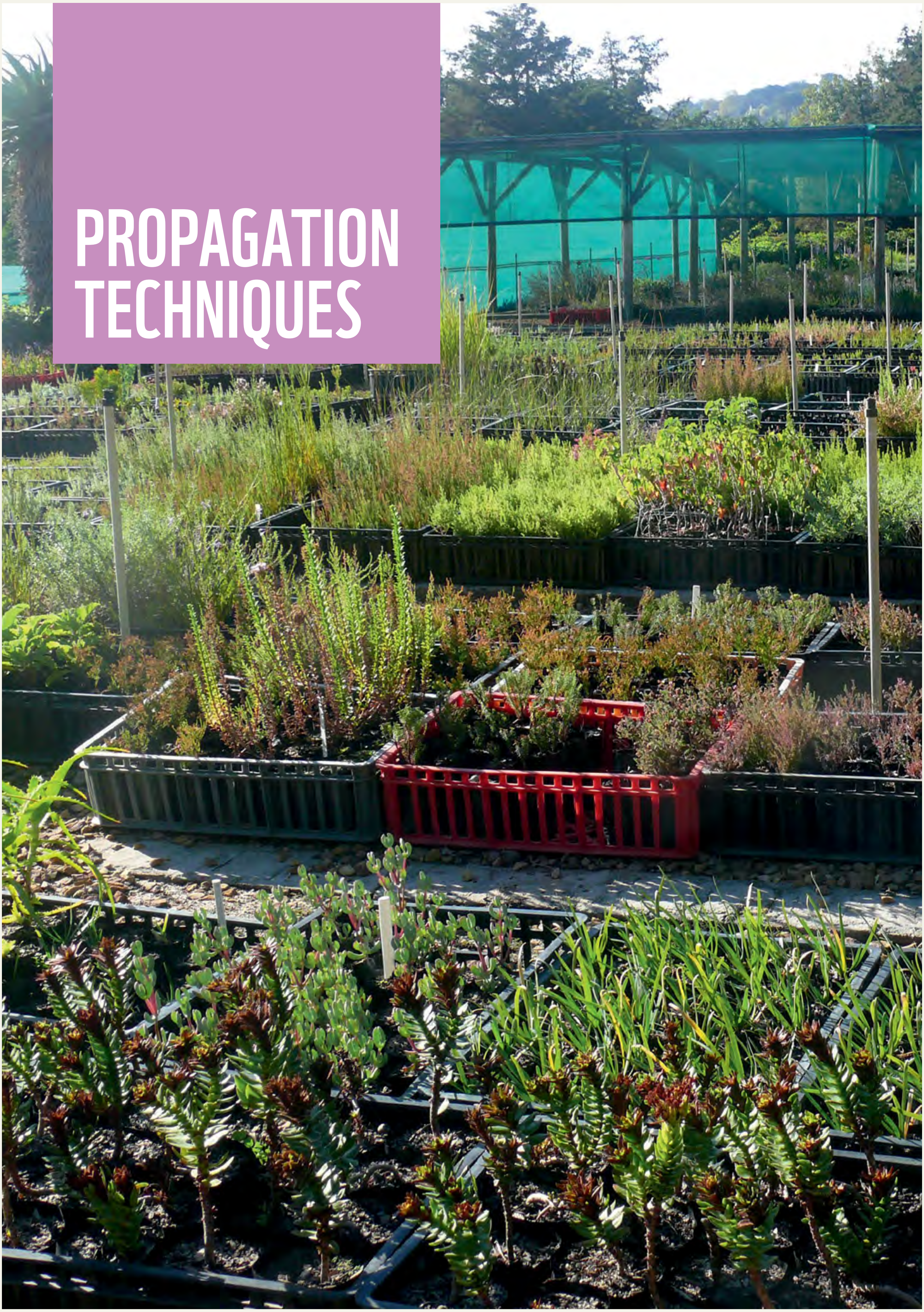
Water seed trays and cuttings with a fine rose spray or watering can.

PROPAGATION TECHNIQUES



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Many different species are propagated and grown for restoration in the Kirstenbosch National Botanical Garden collections nursery.

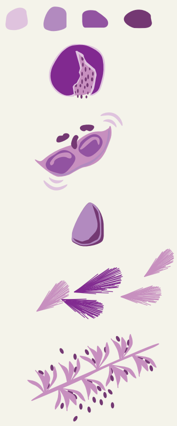
SEED PROPAGATION

Propagation of plants from seed begins with seed collection.

SEED COLLECTION

Seed collecting requires good planning and knowledge or research of flowering and seed-producing times for the required species.

Seeds should be collected at the optimum stage of development. This is usually when they are in the process of natural dispersal, i.e. when seeds are dropping naturally.



Certain signs can be observed when seeds are ready to be collected:
Changes in fruit or seed coat colour
Fruits splitting or breaking open
Seeds rattling
Seeds are hard and dry
Some seeds have already dispersed
Seeds can easily be removed from the plant

In some cases a balance has to be found between early and late harvesting to obtain the maximum amount of good quality seeds. If collection is delayed too long, fruits could split open and seeds drop to the ground, or they may be eaten by birds or animals. It is good practice to visit the collection site regularly to sample seeds and determine their stage of maturity.

Seeds in follicles, pods, capsules, siliques, achenes and cones can be harvested before they are fully mature and then dried. Branches containing pods or capsules can be cut and placed on canvas or in open trays to dry for one to three weeks. Capsules and pods split open and release the seeds.

Where small amounts of seed are needed, the seed-bearing stalks can be cut and hung upside down in a paper bag to dry.

Berries change colour from green to red or black when they are ripe.

Pods and capsules become dry and split open to release the seeds.

HOW SEEDS TRAVEL

By wind

Thamnochortus insignis
(thatching reed)
Restionaceae

Taraxacum officinale
(dandelion)
Asteraceae

Scabiosa incisa
(koringblommetjie)
Dipsacaceae

By animals

Strelitzia reginae
(crane flower)
Strelitziaceae

Xanthium strumarium
(cocklebur)
Asteraceae

Sclerocarya birrea
(marula tree)
Anacardiaceae

By water

Nymphaea nouchali
(blue waterlily)
Nymphaeaceae

Typha capensis
(bullrush)
Typhaceae

Rhizophora mucronata
(mangrove)
Rhizophoraceae

By bursting

Pelargoniums and geraniums
(stork's bill)
Geraniaceae

Cyclopia, Aspalathus
and other Fabaceae

Agathosma, Coleonema
and others in the
Rutaceae family
(buchu)

SEED COLLECTION TECHNIQUES

There are many different techniques that can be used for collecting seed. The most appropriate technique will depend on the species and, in particular, how the seeds are dispersed.

- Hand picking is the simplest technique and works best in species where seeds are shed over a long time period and where fruits are easily accessible.
- Containers can be strapped around the picker's waist, leaving both hands free for collecting.
- The cluster pruning technique can be used when collecting seeds from tall trees or species that produce clusters of seeds at the ends of branches.

  Long tree pruners can be used to remove entire clusters from the tree.
- For species that disperse their seeds via the trigger or ballistic (bursting) mechanism, when protection from animals or birds are required, or when species are hand pollinated, bagging of the seed heads may be needed.

  A mesh bag or a bag made from a material that will let air and light through, is fixed loosely over the seed heads and tied in place around the branch. The seeds will be captured in the bags as they are shed.
- Shaking the branches of trees or shrubs will dislodge ripe seeds that can be collected on a tarpaulin or sheet laid on the ground beneath the plant.
- Grasses, restios and other species with erect flower stalks can be collected by stripping.

  Grasp the seed heads at the base and pull the hand upwards, gently dislodging the seeds, which can then be transferred to a collecting bag.
- Some seeds can be collected from the ground beneath the tree, but care must be taken not to collect seed that has been damaged by insects. However, it may sometimes be beneficial to collect seed from the ground especially where birds and fruit-bats have roosted. These seeds have been naturally scarified and will germinate easily.

  When collecting seeds, they should be stored in paper or cloth bags and never in plastic bags. Seeds with fleshy fruits can be initially stored in plastic bags or in buckets while collecting but the flesh should be removed as soon as possible.

Tip:

For hand picking seeds, strap a container in which to collect the seeds or seed bags around the picker's waist.

Tip:

When collecting seeds from the ground, take care not to collect seeds that have been damaged by insects.

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Seeds are collected and stored in cloth or paper bags – not plastic – to prevent them from going mouldy.

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Seeds are set out to dry in flat trays or boxes. Once dry, they can be cleaned by separating seed from non-seed material.

Hand picking


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Stripping grasses and restios


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Cluster pruning


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Cluster pruning can also be used for grasses and restios if seeds are not completely ripe and are dispersing easily.

Collecting seed from umbel flowerheads


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When collecting seed from umbel flowerheads such as agapanthus, carefully place a bag around the entire umbel, close the bottom, cut the stem and turn the bag right side up and shake. All the seeds will fall into the bag.

Tip:

It's a good idea to take a herbarium specimen with your seed collection so that the species can be verified by an expert.


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Bagging of flowerheads and hand pollination


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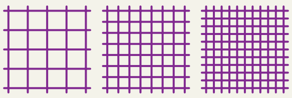
SEED CLEANING

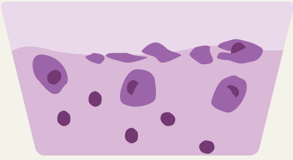
Once the seeds are dry, they can be cleaned. This involves separating the seed from the outer seed coat, and separating seed from chaff or other non-seed plant material that invariably gets collected with the seed.

Hand sorting is the simplest method and is mostly used to clean large seeds or seeds with minimal chaff, such as seeds that are in pods, which only need to be taken out of the pods. Depending on the seed, it can be lightly crushed to break up the outer seed coat, e.g. dried Aloe sp, or it can be rubbed through wire mesh to separate the seed from capsules, e.g. Ericaceae (ericas or heathers).



The resultant mix can then be winnowed or **screened** by passing it through various sizes of mesh sieves. With certain seeds, the chaff can be removed by carefully throwing seed into the air and catching it again, or pouring it back and forth from one container to another. A slight breeze will carry the chaff away and leave the heavier seeds to fall into the tray.

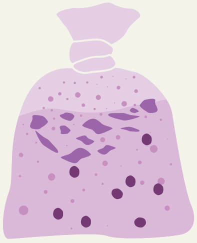
Sticky seeds such as *Pittosporum viridiflorum* (cheesewood) can be rolled in fine wood ash or talcum powder and wiped with a piece of coarse hessian. The dust absorbs a great amount of the sticky mucilage and both are wiped off the seed.



Fleshy fruit or **berries** need slightly different treatment to dry fruits. In general, fleshy fruit is easiest to handle if it is ripe or overripe, but this is seldom the case as seeds need to be collected before birds and animals eat them all.

With ripe fruits, the flesh must be removed from the seeds before the seeds are stored and sown. The berries can be squashed and the seeds extracted by hand. They can be trod in tubs, or they can be soaked in water to soften the flesh. The seeds are then removed in the water or rubbed through screens or sieves under running water.

Another method to remove seeds from small seeded fleshy fruits is to use an electric blender with the metal blade that has been replaced with a piece of rubber tubing. The rubber tubing is fastened at right angles to the revolving axis of the machine. A mix of fruit and water is placed in the blender and stirred for about two minutes. When the pulp has separated from the seed, the pulp can be removed by **flotation**. The seeds and pulp are placed in water. The heavy, sound seeds will sink to the bottom and the lighter pulp and empty seeds will float.



Fermentation is a method that works well for species with sticky or milky flesh such as *Sideroxylon inerme* (milkwood). The seeds can be placed in a strong plastic bag with a litre of water, three tablespoons of sugar and a sachet of instant yeast. These ingredients are mixed thoroughly and the bag is sealed. The bag is left for three to four days until it has swollen. This shows that the fermentation process is well under way and that the flesh is falling off the seeds. The seeds can then be washed in water.

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Fleshy seeds must be cleaned soon after collection.

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Mesh sieves of various mesh sizes are used for cleaning seed.

© VICTORIA WILMAN

Use a rubber bung to crush capsules or prickly seeds through a sieve.

Tip:

Always keep the label with seeds during processing and cleaning to avoid mix-ups.

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Hand sorting large seeds and seeds in pods.

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Grass seeds can be rubbed over a ribbed rubber mat to remove the seeds from the husks. The seeds fall into the grooves in the mat and can then be tipped into a tray.

SEED DORMANCY

Dormancy refers to the period in a plant's life cycle when growth, development and physical activity are temporarily stopped.

Seeds become dormant because the environmental conditions are not suitable for germination and growth – it could be too dry or too cold, for example.

When seeds mature, they develop internal and external dormancy mechanisms that control when they will germinate. This is to prevent a seed from germinating in an unfavourable environment, where it will not survive. If the environment is favourable, the seed will germinate. For most fynbos plants, a favourable environment would be when temperatures are cool in autumn and the rainy season starts in the Cape. Other seeds have a hard seed coat that needs to pass through an animal. The seed will germinate when the animal has taken it to another area, away from the mother plant. This is called **dispersal**.

In many cases seeds naturally dry to a level below what is required for germination. They only need to soak up water at the correct temperature to start the germination process. These seeds do not need any special treatment but need to be sown at the right time, e.g. in the autumn or rainy season. Some seeds need to be sown fresh and will lose viability if they are stored too long before sowing.

Main types of dormancy

Physical or chemical seed coat dormancy

Seeds with **physical seed coat dormancy** have a hard outer seed covering that cannot be penetrated by water or oxygen. In nature, temperature fluctuations, high temperature, fire, mechanical abrasion such as lying in sand, passing through the digestive tracts of birds and animals or the actions of micro-organisms in the soil over time, break down the seed coat and so break the dormancy.

When germinating these seeds in the nursery, this type of dormancy can usually be overcome by **scarification**.

Chemical seed coat dormancy inhibits germination via chemicals found in the fruit and seed-covering tissues. In particular, fleshy fruits or juices from these fruits can stop the seed from germinating.

In nature these inhibitor chemicals are washed out of the seeds by heavy rains, but in the nursery the seed coat must be removed and the seeds must be washed in water.

Internal dormancy

Seeds with **internal dormancy** fail to germinate because of factors within the embryo. Dormancy can occur in some seeds because the embryo is not yet fully developed and needs a period of after-ripening. Seeds with this type of dormancy can be stimulated to germinate when they have been subjected to moisture and a period of high temperatures followed by low temperatures, or vice versa. This is known as cold or warm stratification. Sometimes a period of dry storage is sufficient to break the dormancy. Gibberellic acid can also be used to stimulate germination.

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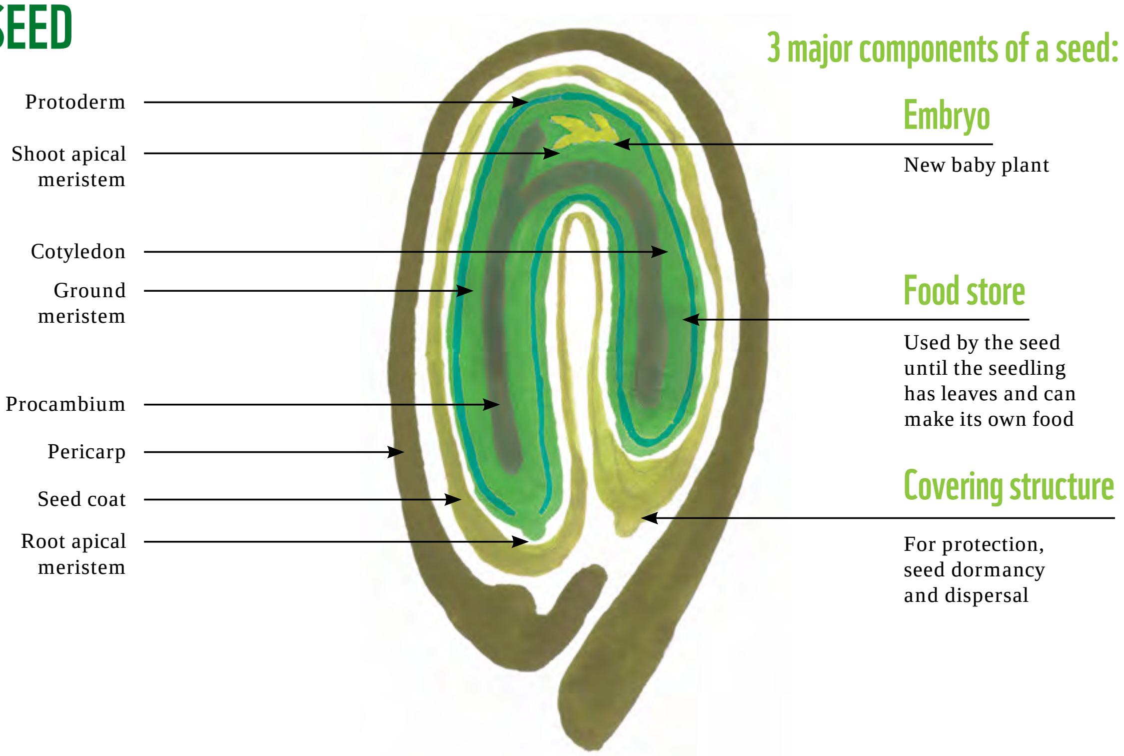
Combinational dormancy or **double dormancy** combines two or more kinds of dormancy. In this case, all blocking conditions must be eliminated in the correct sequence for the seed to germinate. Some seeds may require light or dark conditions, particular or alternating temperatures, or a combination of these.

A SEED



There are several ways in which one can break seed dormancy, depending on the type of seed coating:

8 different ways to break seed dormancy

1. Acid scarification

Acid treatment can be used to break hard seed coat dormancy. It is used for particularly thick and impermeable seed coats. Dry seeds are placed in concentrated sulphuric acid (H_2SO_4) for a length of time, depending on the species and the thickness of the seed coat. The ratio is about one part seed to two parts acid and the amount of seed treated at any one time should not be more than 10 kg. The acid should be at room temperature and containers should be glass or ceramic, never plastic or metal. The seeds and acid can be stirred occasionally with a glass rod, although too much stirring should be avoided as it can cause the acid to heat.

The seeds are removed from the acid after the allotted time, which can be from 10 minutes to 6 hours or more depending on the species, or before the acid penetrates the seed coats. After removal, the seeds can be placed in a large amount of water with a small amount of sodium bicarbonate (baking soda) to neutralise any remaining acid, or they can be washed thoroughly for 10 minutes under running water. After the acid treatment, seeds may either be sown immediately, or dried and stored.

2. Dry heat treatment

Seeds of many species are adapted to germinate in response to direct and indirect cues provided by fire. Heat from flames may break the coats of hard-seeded species such as in *Podalyria calyptrata* (Fabaceae) (sweetpea bush). Dry heat improves germination in members of the Rutaceae (buchus), Rhamnaceae (buckthorns), Ericaceae (ericas or heathers) and Restionaceae (restios) with hard, nut-like seeds. Heat from fire also has a desiccating or drying effect which, combined with wetting, can break the hard seed coats, resulting in germination in *Leucospermum cordifolium* (pincushion).

For this treatment, seeds should be placed in a shallow container in a pre-heated incubator or oven. The specific temperature and time span will depend on the species and the size of the seed and a certain amount of experimentation. Acacia seed, for example, requires two minutes in the oven.
Heat treatment can also be done in a microwave oven. After the treatment, seeds should be cooled and sown.

3. Mechanical scarification

Seeds with hard seed coats can be tumbled in containers lined with sandpaper or mixed with coarse sand or gravel in a revolving container. They can be rolled on a cement floor using a brick or board, or rubbed with sandpaper by hand. Seed coats can be nicked with a knife or cracked gently. Care must be taken not to injure the embryo and it may be necessary to open a couple of seeds to see where the embryo is located to avoid damaging it.

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Seeds with hard seed coats such as these *Erythrina lysistemon* (coral tree) seeds can be nicked with a knife or rubbed with sandpaper, taking care not to damage the embryo.

© VICTORIA WILMAN

4. Hot water treatment

For small to medium-sized seeds or large quantities of seeds, hot water treatment may be more practical. Seeds should be dropped into about four to six times their volume of water pre-heated to 77–100 °C. The seeds should be left in the gradually cooling water for 12 to 24 hours and then planted. Seeds that have not swollen can be subjected to another treatment.

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5. Pre-chilling or cold treatment

Seeds that require cold treatment can be placed on moistened germination substrate and kept at 3–5 °C in a refrigerator for seven days. The treatment may be extended to 14 days for seeds showing more dormancy. After the cold period, the seeds can be sown and allowed to germinate in the (warmer) conditions recommended for the species.

6. Leaching

For seeds with chemical inhibitors in the fleshy fruit and seed-covering tissues, it is necessary to leach or wash these chemicals out. The fruit pulp should be removed first and any inhibiting chemicals left can be removed by soaking the seeds in tap water or by placing them in slowly running tap water for various lengths of time before soaking. When soaking seeds, the water should be changed every 12 to 24 hours. The seeds are sown directly after the treatment.

7. Light and temperature dormancy

Seeds can 'sense' their environment to schedule their germination. The two major natural environmental signals are light and temperature. Seeds perceive **light** – the presence or absence of light indicates how deeply the seed is buried, whether the soil has been disturbed, and whether there are gaps in the canopy. All this could indicate to the seed that conditions are right for germination. The seeds of some species are light sensitive and must receive light during germination. Seeds that require light should not be covered when sown but merely sown on the surface and watered in.

Certain **temperatures** may be required to 'tell' the seeds that the season is good for germination, such as the autumn temperatures required by many fynbos species. The range of temperatures required may be very narrow and specific. Temperature and duration of light and dark can both be required, as for fynbos seeds. These seeds require fluctuating temperatures of 4–10 °C for 16 hours and 20–28 °C for 8 hours. In other words, they will germinate during the hot days and cold nights that happen naturally in autumn. If the recommended temperatures are not available naturally, they must be imitated in a growth chamber or greenhouse at the nursery.

8. Smoke treatment

Seeds of many species are adapted to germinate in response to direct and indirect cues provided by fire. Smoke treatments can cue germination in many fynbos seeds and can be carried out by placing previously sown seed trays in a polythene tent into which smoke is pumped. A mixture of dry and green fynbos plant material is ignited in a metal drum and the resulting smoke is pumped into the tent using bellows or a compressed air line. This system allows the smoke to cool before it enters the tent. The seed trays remain in the tent for about two hours while the smoke settles, after which they are removed and watered.

A simpler method is to place trays in a plastic tent, ignite fynbos material in a small metal drum and then dampen it down to create smoke. The drum is placed inside the tent and the tent is sealed while the chemicals in the smoke settle onto the soil in the trays. The trays can be removed after two hours and watered.

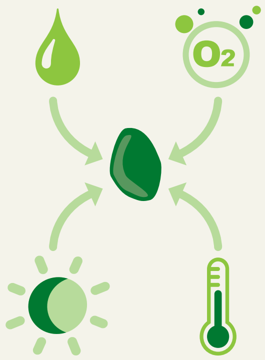
Alternatively, Kirstenbosch Seed Primer can be used. The seed primer is absorbent paper that has been impregnated with a smoke solution and a range of germination stimulators, and then dried and sealed in a polythene packet. Water is added to the paper and seeds are soaked in this solution for 24 hours.

Ignite a mixture of dry and green fynbos plant material in a metal drum and pump the smoke into the tent using bellows or a compressor. Keep the seeds in the tent while the smoke settles. Remove the trays after two hours and water them.

SEED GERMINATION

Germination is the process where seeds absorb water and start to grow and develop after a period of dormancy.

There are four main environmental factors that affect germination and plant growth. These are **water, oxygen, light** and **temperature**.



- The first part of the germination process in seeds is the absorption of water. There should be enough water continuously available for the germinating seed.
- Seeds need to breathe. Dormant seed may need little oxygen, but it is still required. Seeds need more oxygen during germination and the propagation medium in which the seeds are sown should be well aerated. Germination can be severely hindered by sodden, oxygen-poor environments.
- Different species require either light or darkness to germinate.

  Seeds that require light should be sown on the surface and either left, or covered only lightly with fine bark or vermiculite.

  Seeds requiring darkness should be sown deeper and can also be placed in a dark area until germination has started.
- Favourable temperature is another requirement for germination. Some seeds will germinate over a large range of temperatures, whereas others require a narrow range. Some seeds have minimum, maximum and optimum temperatures at which they germinate. The best practice is to find out about the natural ecology and germination of each species and mimic these conditions as best as possible in the nursery.

SEED SOWING

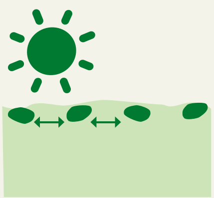
Before filling the seed trays, the trays should be cleaned, sterilised and placed in the sun to dry. The growing medium should be mixed on a clean cement surface. Once the medium and trays are ready, the trays can be filled to a level about 10–20 mm from the rim. This is to keep the water and the medium from spilling over the rim during watering. The medium should be levelled and patted down gently to create a uniform surface. Water it with a very fine rose watering can before sowing the seed.

Tip:

Clean and sterilise seed trays before use.

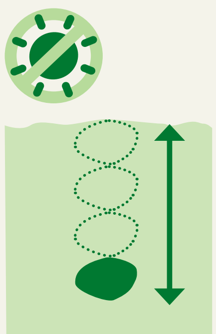
Seeds should be sown evenly and sparingly over the surface of the tray. Seeds sown too densely become overcrowded. Seedlings that have to compete for resources in an overcrowded environment are more prone to disease.

- Very fine seeds can be mixed with sand and scattered over the surface.
- Medium-sized seeds can be scattered or sown in furrows.
- Fine seeds can be gently patted down to give them good contact with the growing medium.
- Large seeds can be sown in rows and pushed gently into the medium.



The seeds can be covered with vermiculite, sifted bark or sifted propagating medium.

Unless they require light to germinate, seeds should generally be planted to a depth of three to four times their diameter. Seeds should be watered with a very fine rose watering can and **labelled carefully**, as explained on page 19, as follows:



1. Name of the plant
2. Date of propagation and potting
3. Name of the propagator (person)
4. Name of the restoration project or restoration area
5. Origin of the plant (where the seeds were collected)

Seeds can be treated with a fungicide such as Apron XL or Previcur N after sowing to prevent losses due to damping off. Seed trays are then placed in the seed house.

The seed trays should be kept moist enough for the seeds to germinate without becoming waterlogged.

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Sowing protea seed in open beds.

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Covering seeds with a fine layer of sowing medium.

VEGETATIVE PROPAGATION

Plants that cannot be easily propagated by seed, or that produce very little or no seed, can be propagated vegetatively (asexually). The main methods of vegetative propagation are stem and leaf cuttings, offsets and division, using various parts of the plant.

Softwood cuttings placed in plug trays in the greenhouse.

STEM CUTTINGS

Stem cuttings may either be softwood, herbaceous, semi-hardwood or hardwood cuttings.

Stem cuttings are segments of shoots that have lateral (side) or terminal (main tip) buds and the potential for adventitious roots to develop.

Stem cuttings can be taken from the tip of the stem with a terminal bud or from other parts of the stem. Some plants can be propagated from either of these, but many plants root best from tip cuttings.

Cutting material should be collected in the cool, early mornings while mother plants are still turgid and fresh. They should be stored in clean plastic bags containing a tiny amount of water to keep the cuttings moist. Cuttings should not be covered in water for prolonged periods, but should be kept moist, cool and turgid at all times.

How to make cuttings

- Cuttings should be made using sharp and sterilised secateurs.
- Stems are cut just below a node and all but the top few leaves are removed neatly with the sharp secateurs.
- Large leaves left on the cutting may be reduced in size by cutting them in half.
- The cuttings are then placed in plug trays that have been filled with a rooting medium. The medium should be well aerated and well drained while being able to retain moisture. The main functions of the medium are to hold the cutting in place, to provide moisture to the cutting, to allow an exchange of air at the rooting zone and to create a dark environment for the cutting base.

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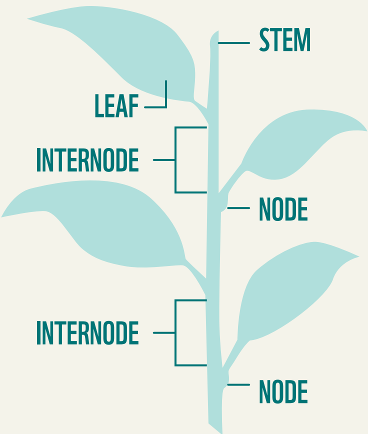
Taking cuttings, cutting just below a node.

Mixture	Components
Cutting mix 1	1 part fine bark and 1 part polystyrene
Cutting mix 2	1 part fine bark and 1 part coarse sand
Cutting mix 3	1 part bark and 1 part perlite

Rooting hormones can be applied to speed up rooting and are sometimes necessary for hard-to-root species. An inexpensive, easy-to-use and effective rooting hormone is Seradix, which comes in various strengths: Seradix 1, 2 and 3. The cutting is dipped into the powdered rooting hormone to form a thin layer on the open cut part of the stem.

SOFTWOOD CUTTINGS

Softwood cuttings are prepared from the soft, succulent new growth of stems and are usually tip cuttings.



The cuttings should not be too soft and tender, as these tend to rot. The best material should be flexible but mature enough to break when bent sharply. Softwood cuttings generally root easier and quicker than other types, but require more attention.

- The cuttings are made by cutting a shoot that includes at least four nodes, two for roots and two for shoots.
- The basal or lower cut is made just below the node. In the case of middle-of-the-stem cuttings without a terminal shoot, the upper cut is made just above the node.
- The leaves on the lower two-thirds of the stem are removed.
- To sterilise the cutting, it can be dipped into a diluted bleach solution, a disinfectant like Sporkill or various broad-spectrum fungicides mentioned earlier.
- The bottom or basal end of the cutting can then be dipped into a rooting hormone for softwood cuttings, such as Seradix 1.

A hole is made in the rooting medium and the cutting is placed into the hole. The medium is pushed firmly against the stem. The cutting is then watered to settle it down and placed in a greenhouse, propagation tunnel or open-air greenhouse with intermittent misting and bottom heat.

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A softwood cutting.

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A rooted softwood cutting.

HERBACEOUS CUTTINGS

Herbaceous cuttings are made from succulent, non-woody plants such as geraniums, pelargoniums or vygies and succulents such as *Portulacaria afra* (spekboom).

- These cuttings can be from 8 to 13 cm long with a few leaves retained at the tips, but they will grow even without leaves.
- Succulent herbaceous cuttings are often left to callus or 'seal' for a few days to a week before inserting them into the rooting medium.
- Rooting hormones are not always required but can be beneficial for the development of heavier root systems.
- Herbaceous cuttings can be rooted under the same conditions as softwood cuttings but can also be rooted in a shade house without frequent intermittent misting.

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A herbaceous pelargonium cutting.

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A rooted herbaceous pelargonium cutting.

SEMI-HARDWOOD CUTTINGS

Semi-hardwood cuttings are usually taken in summer from new shoots that have been allowed to partially mature, after flowering and just after a flush of growth has taken place.

- They are made 7,5–15 cm long and two-thirds of the leaves of the lower portion are removed.
- If the leaves are very large, they may lose too much water and be unable to photosynthesise and make food, which is necessary for root formation as softwood and semi-hardwood cuttings depend on food produced while in propagation. Large leaves may be trimmed to a third or half their size to reduce the leaf surface area, lowering water loss.
- The bottom or basal cut for semi-hardwood cuttings can be made at a slant, or cuttings can be wounded to expose more cambium (the green layer just under the bark). This is where rooting takes place and it will create a greater surface area from which rooting hormones can be absorbed. It may also improve the contact area between the cutting and the medium.
- The rest of the cutting-making process is the same as for softwood cuttings.

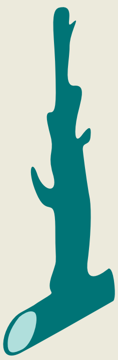
HARDWOOD CUTTINGS

Hardwood cuttings are generally made from deciduous (plants that lose their leaves in winter or summer) or semi-deciduous species and are made using hard, woody material.

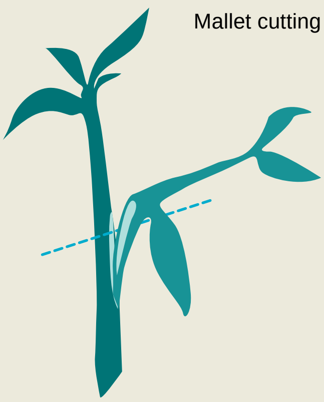
- Hardwood cuttings are taken before the end of winter when the sap is rising and the buds are about to swell.
- The wood is usually from the previous season's growth, but for a few species older wood can also be used.
- Material should be taken from healthy, moderately vigorous mother plants.
- The wood should not have abnormally long internodes, nor be from small, weak interior shoots.
- In general, hardwood-cutting material is ready when the leaves can be removed without tearing the bark.
- Hardwood cuttings can be from 10 to 76 cm long. The smaller cuttings should have a diameter of 0,6 to 2,5 cm. Very long cuttings, whose diameter can be more than 40 mm, are called **truncheons**.
- Hardwood cuttings can also be wounded as in semi-hardwood cuttings.
- Deciduous cuttings are made without leaves, but hardwood cuttings can also be made from narrow-leaved evergreen species, in which case some leaves remain on the tip of the cutting.
- Cuttings can be treated with a hormone such as IBA at 2 500 to 5 000 ppm or Seradix 3 for hardwood.
- Hardwood cuttings can be rooted in a greenhouse with bottom heat of 18 to 21 °C. These cuttings can also be rooted in a shade house but must be kept moist.

Tip:

Hardwood cuttings should not be allowed to dry out during handling and storage.



Mallet cutting



Heel cutting

Straight cutting

Mallet, heel and straight cuttings

Three different types of hardwood cuttings can be made, namely **mallet**, **heel** and **straight** cuttings.

A **mallet** includes a short entire section of stem of the older wood while a **heel** is pulled off the old stem, taking with it a small piece of the older wood.

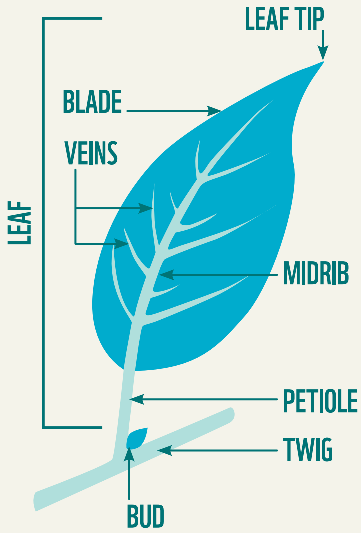
Heel cuttings are usually made from semi-hardwood and hardwood cuttings. Species of erica and buchu propagate successfully from heel cuttings.

- This type of cutting is made by tearing a side shoot off the main stem so that a part of the main stem remains attached to the base of the cutting. This is the heel.
- Rooting takes place at the callus tissue that forms around the heel.
- The lower leaves are removed and the cuttings are rooted under the same conditions as for softwood and semi-hardwood cuttings.

A **straight cutting** is the most commonly used and does not include any older wood. The straight bottom or basal cut is made just below a node while the top of the cutting is made above a node and is cut at an angle to make it easier to distinguish between the top and the bottom of the cutting.

LEAF CUTTINGS

Some plants can be propagated by means of leaf cuttings, where the leaf blade or the leaf blade and petiole (leaf stalk) are used as cutting material.



Adventitious buds, shoots and roots form at the base of the leaf and develop into a new plant. Species such as Streptocarpus (Cape primrose), Sansevieria (mother-in-law's tongue), Gasteria (ox tongue), Haworthia (zebra plant), Crassula (jade plant) and Kalanchoe can be propagated in this way. Some bulbs or geophytes can also be propagated by leaf cuttings, including Lachenalia (wild hyacinth) and Haemanthus (paintbrush lily).

- The leaf is removed from the mother plant by slicing cleanly through the petiole so that about 5 cm of stalk is attached to the leaf. A small hole is made in the propagating medium and the leaf petiole is inserted into the medium at a shallow angle so that the leaf blade lies almost flat on the medium and the stalk is close to the surface. The medium is pressed down firmly around the stalk. New plantlets will form on the cut surface of the leaf stalk.
- In one method, the long tapering leaves in species such as Sansevieria (mother-in-law's tongue) are cut into horizontal sections of 8 to 10 cm long. Three-quarters of the leaf section is inserted into the rooting medium and after some time, a new plant forms at the base of the leaf piece.
- Plants with fleshy and usually hairy leaves such as Streptocarpus (Cape primrose) can be propagated by making incisions into the large veins on the underside of the leaf. The leaf is laid flat on the surface of the propagating medium and pinned or held down with the upper surface of the leaf exposed. New plants form at the place where each vein was cut and the old leaf gradually disintegrates.
- Some leaf cuttings can be made by cutting large leaves into triangular sections, each with a section of a large vein. These leaf pieces are then inserted upright into sand with the pointed end down. The new plant develops from the large vein at the base.

Well-developed, healthy leaves should be used and leaf cuttings should be rooted under the same conditions of high humidity as softwood cuttings.

Tip:

Well-developed, healthy leaves should be used for leaf cuttings.

Dipping leaf blade into the rooting hormone.

Planting leaf blade cuttings.

OFFSETS AND DIVISION

Some plants can be propagated vegetatively (asexually) by separating or dividing them.

Offsets are produced by some species such as cycads, some aloes and many bulbs. An offset is a lateral or side shoot or branch that develops from the main stems.

- Offsets can be removed by cutting them off close to the main stem with a sharp knife.
- Some offsets may have already produced roots and can be planted directly.
- If the offsets are not sufficiently rooted, they can be placed in a rooting medium and treated in the same way as a leaf cutting.

Many herbaceous perennials and grasses produce their new shoots from crowns at the surface or just below ground level. These can be increased by **division**.

- The plant is lifted out of the ground, usually in the spring just before new growth begins.
- It is either separated by hand or cut into sections with a knife or other sharp instrument.
- These divisions can then be planted straight into the veld or into bags for growing on.

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Division of agapanthus by cutting into sections and replanting.

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Offsets, *Prionium serratum.*

PLANTING ON SITE

This guide has outlined some propagation techniques and provided information on the general guidelines for growing plants to plant back into nature as part of a restoration programme.

The next step for any enthusiastic plant propagator is to read as much as possible about the desired species and to mimic in the nursery the natural environment in which the plants grow and regenerate.

Once the plants grown for restoration have been successfully propagated, they are planted into containers and placed in shade for a few weeks until they are ready to be moved out into the sun. Watering is reduced at each stage to harden the plants off and prepare them for planting on site. Hardening off is particularly important when growing for rehabilitation as plants only receive water from natural rainfall after they are planted.

Planting on site should ideally take place during the rainy season. The plants are transported to the rehabilitation site and placed under a temporary shade structure and kept moist, if possible, until they are planted. Care should be taken during the transportation stage that plants do not become damaged due to rough handling. Planning should be such that plants do not remain out in the veld for too long or over weekends without watering.

Plants should be placed deep enough into planting holes to allow for a shallow bowl around each plant to collect moisture. If possible, plants are given an initial watering at planting, after which they rely on moisture present in the soil and natural rainfall.

If care is taken at each stage in the process, it is possible to rehabilitate a degraded landscape so that it can become a functional ecosystem again.

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Planting threatened species in Tokai Park in Cape Town.

GLOSSARY

Achenes	A dry one-seeded fruit that does not open to release the seed.
Adventitious roots	Roots that are formed from areas of the plant other than the root, such as stems or leaves.
Bulbs	Structurally a short stem or basal plate from which a growing point or flower arises. This is enclosed by concentric layers of fleshy leaves that function as food storage organs during dormancy and dry periods.
Callus	A soft tissue that forms over a wounded or cut plant surface, leading to healing, which arises from cells of the cambium. This is also where roots form on cuttings.
Capsules	A dry fruit that releases its seeds by bursting open when ripe, such as a pea pod or Gladiolus pod.
Catchment	The geographic, usually mountainous, area from which rainfall accumulates and flows into a river, lake, wetland or reservoir.
Climbers	A plant that grows upwards by attaching itself to other plants or objects.
Cones	The dry fruit of conifers or Leucadendron (cone bushes), typically tapering to a rounded end and formed of a tight array of overlapping scales on a central axis which separate to release the seed.
Cultivation	The act of caring for or raising plants.
Damping off	A disease caused by several different pathogens which affects seedlings before or after germination. Stems often rot at soil level and the seedlings die.
Deciduous	Plants that lose their leaves or become dormant either during winter when it's cold, or summer when it's dry.
Dormancy	A period in an organism's life cycle when growth, development and (in animals) physical activity are temporarily stopped.
Ecosystem	A biological community of interacting organisms and their physical environment.
Ecosystem services	Services and benefits provided by nature or ecosystems, such as water, climate control, soil, recreational benefits, oxygen, etc.
Endangered species	A species that has been assessed as having very few populations or individuals left in the wild and is at risk of extinction.
Endemic species	A species that is only found in a particular region or area.
Evergreen	Plants that do not lose their leaves or become dormant during winter or dry periods.
Fermentation	The process where fruit breaks down and becomes softer and is easier to remove from seeds.

Follicles	A dry fruit that is derived from a single carpel (ovary, stigma and style) and opens on one side only to release its seeds.
Geophyte	Plants that have underground storage organs such as bulbs, corms, tuberous roots or rhizomes that store water and nutrients during unfavourable conditions.
Germination	The process whereby a seed overcomes any dormancy, absorbs water and starts to grow and develop.
Grasses	Herbaceous plants with jointed stems and spikes of small wind-pollinated flowers, leaves with blades and sheaths at the nodes along hollow culms/stems.
Greenhouse	A glass/polycarbonate-enclosed structure for propagating plants, particularly from cuttings. Also used to grow plants that need protection from cold or need particular environmental conditions that can be simulated inside a greenhouse.
Growing on	The process after potting and hardening off when the plant is placed in its final growing area to grow up.
Habitat	The natural home or environment of an animal, plant or other organism.
Herbaceous perennials	A non-woody plant whose growth may die down annually but whose roots or other underground parts survive. Also a non-woody plant that only lives for 4–5 years.
Herbarium specimen	Pressed and dried plants that have been mounted together with a data label. A type specimen of all species is kept at national herbariums. The species description and Latin name are based on these specimens. Plants collected in the field can be sent to the herbarium for verification of the species. Field herbariums of species can be kept for easy reference.
Indigenous species	A species that naturally occurs in a region.
Leaf blade	The broad flat part of a leaf.
Medium	Soil or other components in which plants are germinated, rooted or grown.
Mother plant	A healthy, adult plant from which growers take cuttings or collect seeds. Cuttings, or clones, as they are often called, are expected to grow into adult plants that have the same genetics as the mother plant.
Node	The part of a plant stem from which one or more leaves or buds emerge, often forming a slight swelling.
Petioles	The little stem that attaches the leaves to the main stem.
Potting shed	A shed or structure that is a work area for potting plants into pots and trays.
Potting soil	A medium in which to grow plants in pots after the propagation stage is completed.
Propagation	To grow a new plant from a parent plant or seeds by using a variety of different means.
Propagation house	A building similar to a greenhouse where the process of growing new plants from a variety of sources like seeds, cuttings and other plant parts takes place.

Pruning	A horticultural practice involving the selective removal of certain parts of a plant, such as branches, buds or roots.
Restios	A wiry reed-like plant of southern Africa, used for thatching and brooms, with green culms/stems without obvious leaves and with split leaf sheaths occurring along nodes.
Secateurs	Sharp cutting tools used for making cuttings and pruning.
Sedges	Plants with solid and often triangular culms/stems, bearing flowers not right at the tip and leaves and leaf sheaths clustered at the base of the plant.
Seed house	A shaded structure with raised benches or open beds for germinating seeds.
Seed primer	Absorbent paper that has been impregnated with smoke solution. Water is added to the paper and seeds are soaked in this solution for 24 hours.
Seedling mix	The mixture of different soil or soil-like ingredients in which seeds are sown and germinated.
Shade house	A structure enclosed by shade netting that allows required sunlight, moisture and air to pass through, creating an appropriate microclimate conducive to plant growth.
Shrubs	A woody plant that is smaller than a tree and has several main stems arising at or near the ground.
Side shoot	A side-growing shoot that arises from a stem.
Siliques	The long, narrow seed pod of many plants of the cabbage family, derived from two carpels splitting open along both sides when mature.
Smoke treatment	A mixture of dry and green fynbos plant material is ignited in a metal drum and the resulting smoke is pumped into a tent containing fynbos seeds using bellows or a compressed air line.
Succulents	Plants that have some parts that are more than normally thickened and fleshy, usually to retain water in arid climates or soil conditions.
Transplanting	The process of removing a plant from the place where it has been growing and replanting it in another place.
Tributary	A smaller river or stream that connects to, and flows into a larger river or lake.
Vegetative cells	Cells of plants that are actively growing.
Water shadow	The area around plants where water from a sprinkler system reaches.

USEFUL RESOURCES

Organisation	Website	Topics
Botanical Gardens Conservation International (BGCI)	bgci.org	Various topics
Brahms online (SANBI)	newposa.sanbi.org	Localities Herbarium records
Millennium Seed Bank Resources	kew.org/science/our-science/projects/banking-the-worlds-seeds brahmsonline.kew.org/msbp/Training/Resources	Seed information Propagation protocols for South African species
Plantzafrica	pza.sanbi.org	Individual species information How to propagate
Sabonet	sanbi.org/document-type/sabonet-publications	A free resource Books on a variety of subjects
Society for Ecological Restoration	ser.org	Restoration
South African National Biodiversity Institute (SANBI)	sanbi.org bgis.sanbi.org	Vegetation maps General information
WWF	wwf.org.za	General and specific conservation projects

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LASHER

1,44 BILLION

cubic metres of water lost to alien plants nationally every year

COMMUNITY-RUN NURSERIES

propagate and stock plants required for replanting into the veld

ECOLOGICAL RESTORATION

fixes, renews and restores degraded or damaged ecosystems and habitats in the environment

22

strategic water source areas in South Africa

ACTIVE RESTORATION

increases water flow in rivers and streams by planting indigenous plants back into the veld

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