# Frontier Labs

Plant tissue culture with Dr. Andy Hackland at Frontier Labs, Cape Town.

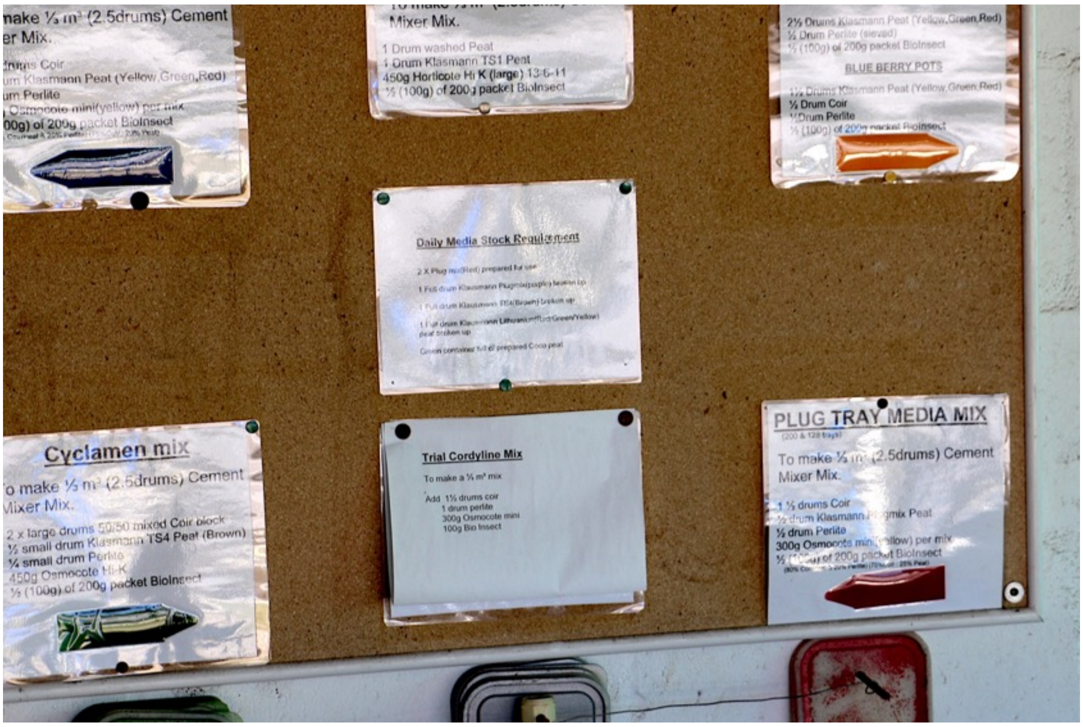
Left. Tissue culture protocol. Jars of the correct determined size according to known plant growth. Jars are sterilised in sterilisation units, and filled with agar gel, and the right amount of salts/mineral solution added.

Below. Plant varieties are tissue cultured from a mother stock and placed in jars. The “daughter” stock are cultured with a root retardant, stem growth hormone, until plant reaches sufficient size. Root growth hormone is then added to bring root growth required for planting into potting medium. The plants are cultured in the lab under 16 hour lighting conditions.

Potting media, is selected according to its abilities of wettability, high cation exchange ratio, and permeability for encouragement of superior root growth required for good stock.
Left. Different grades of Peat imported from Europe, has good sanitation, and is reliable and consistent in quality.

Right. Washed and balanced Coconut fibre (Coir) used and mixed with the Peat in different ratios.

The coconut fibre is sourced from Malaysia where it is washed to remove sodium that is present in the raw product. This is mixed with peat in the correct ratio, giving a balanced pH of around 6. Perlite is mixed in to add water retention properties. (below)




Above. Recipes for potting media according to plant types. Osmocoat is added to some mixes. Media is placed in correct proportions into a spinning barrel and combined.
Below. The lab propagated seedlings are taken from their glass tissue culture units, washed from agar, and planted into punnet filled with correct potting media according to their type. While planting the seeds are kept moist with spray to avoid drying out, and immediately placed in a humidity tent. The covered punnet are then placed into the shade house.

Above. Water is a precious commodity in South Africa, likewise quality of water. Generally the level of salts and minerals is too high in bore or mains water, so water if pumped from bore to filler tanks to the left, and passed through a sodium filter then on (at rear) to the reverse osmosis unit. The purified water is collected in the tank to the right and fed to the nursery and used in the laboratory.

Below. Plants are placed, from the darker conditions of the growing lab, in punnet of potting media with a humidity crib around them. These are placed to the rear of the shade house, first under the potting tables to limit shock of light exposure. Then in a week or so, to the rear of the shade house where layers of material block the strength of light. As they photosynthesise and grow green, the plants are moved toward the front of the shade house. Here the light is stronger. Fans blow to the front moving air through from the back where water cooling walls are positioned. Wet fibre sheets are placed above the plants. This creates a cooling effect dropping the temperature within several degrees.

Left. The rear wall of the shade house. Water runs down the medium, and air passing through driven by fans to the front of the house, is cooled and flows through the shade house maintaining coolness and humid during hot days in summer.

Left and below. New seedlings in humidity crib are placed in the darker, cooler environment under the trestle tables till they are strong enough to handle more light.

Above. This blueberry and cyclamen stock are grown on water flooding irrigation beds. Yellow sticky cards are placed to monitor presence of thrips or other potential pests.

Left. Each blueberry stock has been transferred from the lab mother stock and when roots formed, placed in potting media and put beneath a humidity crib (below). Once fully taken to the punnet, the stock is placed in the open in the shade house ready for sale.

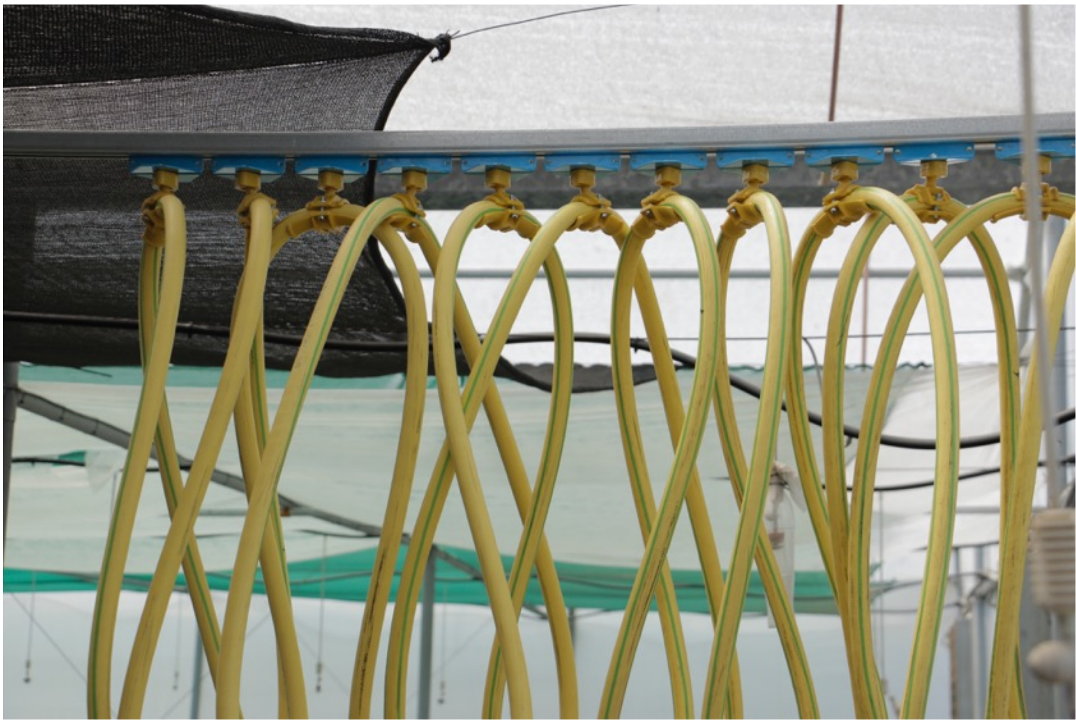
Above. Humidity cribs with water cooling fabric at top, and water cooling wall to the rear. Keeping the correct temperature below 29 - 33 degrees during summer is important for healthy seedlings achieved by the air cooling effect of the moist fabrics and fan drawing air through the house.

In order to maintain correct temperature during winter where 2 degrees can be experienced, heated water coils toped with aluminium sheeting embedded in foam, is placed under the seedlings on the tables. This keeps the seedling roots at around 18 degrees during winter days, ideal for continued growth and development year-round.

The hot water is controlled via taps at the ends of the beds and regulated by a controlled thermostat. (Below)

Left. Beds are kept off the ground to ensure good hygiene and air flow limiting risks of disease and pests.

Right. Water hoses are connected via a sliding mechanism to avoid the hassle of dragging watering hoses around beds and pots in the shade house.



Right. These rootstock fruit trees, cultured and grown in the lab, are awaiting grafting and budding after attaining correct size in shade-house.

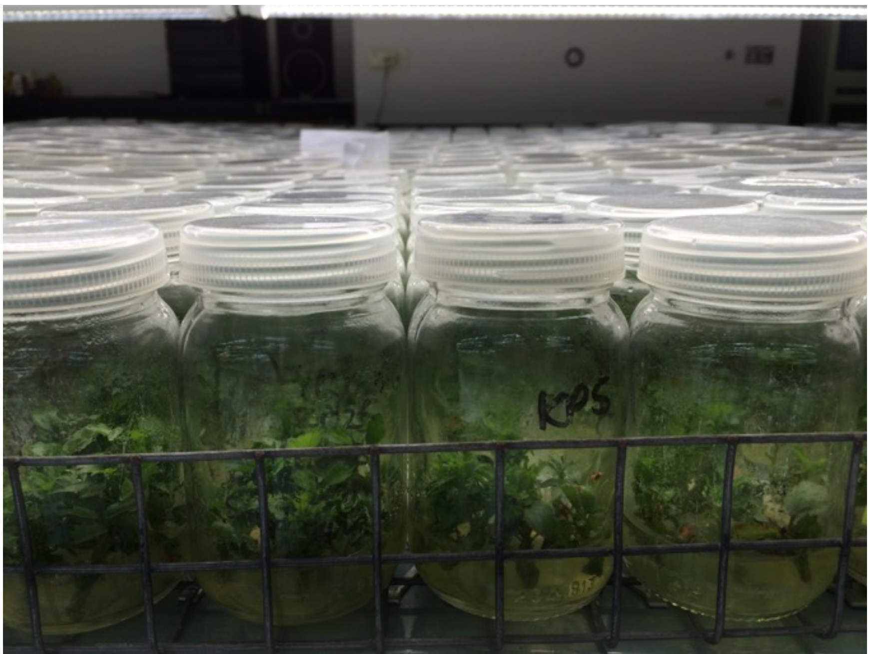
Left. Plants are tissue cultured in the lab. Far left rows, plant cuttings are placed in agar saturated with a sugar, and mineral solution. A hormone is added with causes the cutting to split and reproduce “daughter” clones of itself. These are removed and placed in separate containers to continue this process. (left rows). A root growth retardant / growth stimulant hormone is added at this stage. Once desired size is reached, the shoots (right rows), have a root growth stimulant hormone added and these are ready to be planted once reached appropriate growth.

Right. The early beginnings of a blueberry. The cutting is taken from desired stock and placed in sterilised agar gel with growth hormone (name) which causes the cutting to split into other plants (daughter plants). 3 to 6 can be reproduced this way from the single cutting over a few weeks.

Left. the resulting daughter plants from the cutting are placed in a seperate jar and cultured to produce growth then root growth. If more blueberry plants are desired, these have a hormone added which will produce further plants each, quickly raising the number blueberry plants available.


Left. Tissue culture of Papaya in the process of producing daughter plants.

Below right. Plants are normally allowed to photosynthesis under lights for about 16 hours per day, however some have been trailed in darkness, (placed in boxes) till they have reached the stage to begin root growth, and then moved to the light to green up. Bottom left shows the shoots cultured in darkness, and then exposed to the light which root growth appears to green up left). This method is trialled for use for energy cost reduction. Recently fluorescent lights were changed with LED lighting which reduced energy by 60%, reasons being fluorescent lights also produce heat which places load upon the air-conditioning needed to keep the room at 22-24 degrees.




Right. Plants are handled in this air flow unit for hygiene. The air flows in from the top and is purified from dust particles and flows towards the person handling the plants so as to stop any breathing or dust particles from entering the cultures. For perfect cessation of any kind of contaminate from entering the culture, each worker should be fully dressed in a plastic isolation suit with gloves. Since this inhibits productivity, cotton lab suits are worn and workers was their hands with a sterilised solution and wear breath masks. This limits but does not eliminate contamination, however contaminates are kept in check from growth with faster turn arounds, and quarantines if occuring. Contaminates are usually fungi spores, or bacteria which will quickly from within the containers in the agar gel, and contaminate the plant rendering it useless to use.

Below. These daughter plants are successfully growing roots ready for transfer to punnet.

All plants are processed with maximum efficiency and hygiene in mind. Many of the plants such as the Blueberry seedlings that have hardened off in the shade house, are then sold to a Nursery in the outer Cape area, who follows the same rigid guidelines to continue to grow them to a more advanced state ready for sale to farms. Many Nurseries cannot do Tissue Culture themselves, and so buy from established labs who have learned through trial and error, and advancements in industry practices, to grow consistent high quality cuttings that will establish quickly and grow.

## Arboreta

This nursery is in the western Cape area, and boasts a wonderful array of trees grown to 4 or 5 years old and sold. A large scale nursery, and supplies a number of retailers.

Left. Trees are grown close together to avoid weather damage, and pots placed directly on tough plastic for a low-cost and effective barrier against pests and diseases in the soil.

Below. The health and cleanliness of operations in Arboreta is reflected in the healthy foliage of the trees and shrubs. The African Fire tree (bottom right) is a popular ornamental tree in SA, and boasts a wonderful red flower.

Right. Trees are not all they grow at Arboreta, as the Nursery also propagates some lovely flowering plants for retail, and aloe trees for pot sales.

Below. Smaller trees propagated from cuttings or seed, are protected in shade house areas, and cuttings are kept in a specialised shade house until they have matured enough to be moved into a shade house.


Above top. Cuttings are kept in styrofoam punnet in a warm, moist environment provided by a heating unit (inset) that warms the concrete beds under the trays keeping an ideal temperature of 25-28 Celsius. A mister provides humidity (above) required for optimum cutting rooting and growth.

Overall, the Nursery was a wonderful example of combining cost effectiveness, while maintaining a high quality product through hygiene, quality watering, and correct potting media.

## Vredendal Nursery

Vredendal Nursery is situated inland in the Western Cape along the Olifants River. The Nursery is just above the high flood line, though on rare occasions is inundated. This area is very hot and dry most of the year except winter. The conditions create good growing conditions for many plants as long as irrigation and shade cloth is set up.
This nursery is one of the largest in the area, and supplies daily to retail and wholesale outlets in the cape.
The success of this Nursery, is due to its excellent product of uniformity, and excellent presentation, and its control of disease and weeds. This is attained by practices outlined below, to ensure disease and weed free conditions.

Top left. Several acres of shade are erected and various plant types are grouped according to type. Bottom left. All plants are spaced and placed off the ground to ensure airflow which limits disease impact, and ensures uniform foliage growth.


Above. Pots are spaced to avoid disease. Pots are placed on plastic for hygiene. Under the plastic several inches of gravel have been placed to ensure drainage and a barrier from potentially harmful pathogens.

Below. Seedlings are either grown from seed, or from cuttings which are placed on heat beds in a plastic tunnel. Water is heated (left) and circulated through the beds to keep the roots at a constant temperature of around 24-27 degrees.

Right. Once seedlings are large enough, they are potted in sterilised pots with a sterile mix of Peat, Coir, Perlite, and various additives according to the plants needs. The potting shed material is kept on plastic, which is laid out on gravel to reduce the risk of infection and infestation of weed seeds. Weeds are a big problem in Nurseries if certain standards are not in place. Vredendal has weed-free operations because of their attention to hygiene during potting, the media they use, and installation of mesh and windbreaks to stop seeds blowing in.

Left. Irrigation is achieved through dripper and overhead spray in the larger areas (below). Below. Plants are grouped according to kind, and spaced out according to foliage size to ensure airflow, and uniformity of growth.

Left. Various hanging pots are filled with flowering plants for an attractive display for sale in Retail stores.


Babylonstoren is a 5 star tourist resort with large gardens surrounding the estate. The buildings were built in 1690 by Dutch settlers. Today the estate boasts a large vineyard, and unique gardens surrounding the guest house.

The gardens are designed to incorporate fruiting trees, aloes, cactus, and ornamental trees in a european-style hedged garden. Straight clean lines and uniform blocks are the character of these gardens.

Below. Straight clean lines to a fountain bordered by hedging and overhead vines, and grapevines.

A diverse sectioned garden of displays, and various plants incorporating wide gravel paths and clean lines.

Various displays in different parts of the garden add to its attractive and unique appeal. Right. The Dutch farm buildings built over 300 years ago.
Below. Magnificent view of the picturesque Olifants River valley, and surrounding mountains giving the garden a magnificent backdrop. The estate produces wine, and is a popular tourist destination.

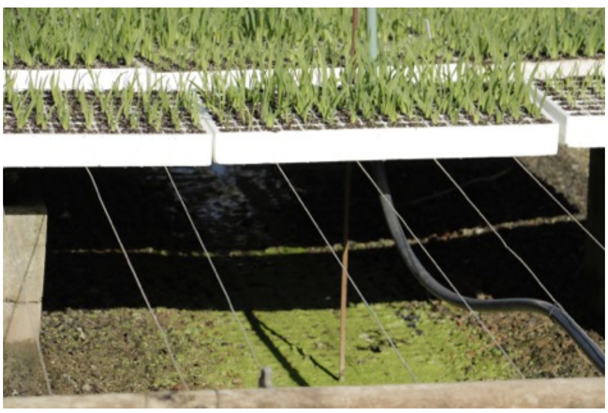
# Samgro Nursery

Samgro Nursery is located closer to Cape Town. This nursery has grown rapidly from smaller beginning to a successful operation. The Nursery produces a wide range of flowers, trees, and vegetable plants for sale to Retailers and Landscaping.

Left. Seeds are propagated by either seed (seeder machine below left) or by cuttings. The seedlings are placed on hotbeds.

Left. Misters keeps the seedlings at the correct moisture. This is controlled by a temperature and humidity sensor (below). Temperature is adjusted by the wet wall seen to the rear (left), and fans that draw air through the wet wall, drawing cool, moist air into the tunnel. (over page). The misters are controlled according to humidity levels detected by the sensor.

Left. Growing lights are positioned above the plants, and timed to give them an extra 8 hours of light during the night.
Below. Pots and trays are placed on wire racks, which is a cost saving and effective feature for airflow and keeping things off the ground.



# Defynne Nursery

This Nursery is situated on a large vineyard, and plum orchard. Though these crops are primary producers for the property, a strong focus has been placed on the new and up and coming nursery. Built to a budget, the Nursery followers a circular pattern from propagation shed to the non-shaded hardening-off section.

Left. Plants are spaced so as to avoid diseases and create airflow and uniform foliage growth. The use of drip watering, reduces water costs.

Above. Keeping to the bare minimum whilst maintaining high plant quality standards and productivity. Recycled bricks make an excellent low-cost barrier between potential harmful pathogens while maintaining airflow. Watering is via drip irrigation which, once installed, is more cost effective.

Left. Heating beds for seed and cutting propagation. The beds are filled with sand and hot water pipes regulated by a thermostat, keep the beds at the right temperature.

Left. The final product is hardened off in the sun and placed on orders.

## Cape Floral Kingdom: Fynbos

The Cape Floral Kingdom of South Africa is one of the plant kingdom of the world with many species endemic to the region. There are over 9000 species of Fynbos endemic to the Cape. The plants in this region are collectively known as 'Fynbos' which means 'Small leaved plants' in Africans, however typical Fynbos foliage is ericoid rather than fine in shape. Fynbos is attributed to a vegetation where 4 plant groups/Families are present as the dominant vegetation. The families are Ericaceae, Proteaceae, Restionaceae and added to these is the plant group of winter rainfall bulbs (geophytes). There are other significant families and genera that are found in fynbos, but these do not determine the fynbos status of the vegetation. They are however important since there are significant numbers of species i.e. Rutaceae. These species are mostly flowering plants that make the region famous, especially during spring or after a fire.

Ericaceae species are very prevalent in Fynbos with a diverse range of colour and appearance. Erica species are small leaved heath plants. Some are rare such as *Erica nevillei*, which is endemic to Table Mountain National Park area. Others are widespread and flower profusely during late summer, such as *Erica mammosa*, and the Fire Erica, *cerinthoides.*
Many Protea types look very similar at first glance outside of their flowering season, but upon observation of the leaf structure, and flower type, they are very different. *Mimetes fimbriifolius,* this species and Leucospermum conocarpodendron have glandular tips to their leaves called extra floral nectaries which attract insects. *Leucospermum conocarpodendron* compared with *Mimetes fimbriifolius, Lsm conocarpodendron* has more and more prominent extrafloral nectaries, *Mimetes fimbiriifolius has smaller and narrower leaves and three nectaries.* During flowering, the plants are easy to tell apart, as *Leucospermum conocarpodedron* puts forth a magnificent display of large, yellow, flower clusters with many 'pins' (long stigma) proceeding forth from the flowering head.

An important Protea species grows in the upper parts of the Kirstenbosch Botanic Gardens, where it grows on the lower slopes of Table mountain and in danger of extinction. This Protea species has many soft hairs on its leaves (Pubescent lamina) giving it a silvery appearance, hence its name "Silver Tree" (Leucadendron argenteum). *Leucadendron* species are cone-bearing Protea. The cones holding seeds, mature and harden after flowering.

Soil type is very important for health and growth of Fynbos species in the Cape Floral Kingdom. Table Mountain Sandstone is made up predominantly of "quartzitic sandstone, shale, and Granite soil characterise different soil/plants types in one area. On each soil type, different Erica and Protea species thrive. Most fynbos species are dependent upon soil type. Therefore some are only found in quartzitic sandstone soils whereas others prefer granitic soils. Propagating them in a commercial setting requires knowledge on the best soil mix for each different species. Some do well in varying soils, while others are very fussy and hard to grow outside of their natural habitat. Getting the potting media mix right for each different species of Fynbos is important to avoid die-offs. Generally, the plant group families that constitute Fynbos, (Proteas, Erica, Restio, and Geophytes) grow on poor quality, low nutrient (particularly nitrogen and phosphorus) acidic soils typical to the region ranging from quartzitic sandstone, to more granite based sandy soil. These plants do not like poorly drained boggy, rich soils, nor addition of nitrogen fertiliser, though some specialized fynbos is found in boggy soils where the water seeps through providing oxygen.

Many Fynbos species are endangered, rare, and some extinct due to human encroachment on their native habitats around Cape City. Climate trends have shown to place Fynbos at risk of extinction if trends continue. Conservation efforts have been made to ensure diverse stock of species is cultivated, and protection of native areas.
A problem over the past few years has been the number of fires in Fynbos areas. Typically Fynbos burns only once every 10 or more years, though fire frequency depends upon the area and annual rainfall. Therefore areas receiving more rain may burn on average of every 10-25 years; whereas in dry fynbos with low rainfall and slow recovery the gaps between burns should be much greater to allow enough time for recovery. Fynbos is a fire dependent. it needs fire to clear away old senescent plant material and encourage germination of the soil seed bank and resprouters to grow. Too frequent or too little fire results in loss of species richness, if the fynbos burns too often the woody shrub element will not have time to recover and produce seed to re-charge the seed bank. Too frequent fire will result in loss of species and fynbos is replaced by grassland and weedy pioneer plants. Many Erica species do not respond well to fire, because they do not have time to mature and produce seed before the next fire.

There are two kinds of fire-adapting Fynbos: re-sprouters, and re-seeders. Re-sprouting Fynbos, respond to fire by re-sprouting from rootstock at the base of the plant and growing out into the dead foliage left behind by the fire. The dead twigs and branches protect the plant somewhat while it grows new shoots. An example of a re-sprouter is the Protea species *Leucospermum hypophyllocarpodendron. Lsm conocarpodendron* has thick, corky bark with epicormic buds that can sprout from the trunk if the plant is not too badly burnt. Some Geophytes such as *Haemanthus sanguineus*, only flower when smoke has stimulated the plant. Soon after fire, they put forth brilliant red flower clusters.
All Erica species without a rootstock are killed by fire. These species rely on seed to recruit.

The bringing back of an extinct species of Fynbos has been a highlight of conservation work conducted with the Kirstenbosch National Botanic Gardens in Cape Town. The last herbarium specimen was collected in 1908 and seed was collected for Kirstenbosch in 1917. In 1980, Deon Kotze, a horticulturalist specialising on ericas at Kirstenbosch, for lost erica species, and *Erica verticillata* was hight on the priority list. A chance conversation between Deon and a scholar, David von Well in 1984, led to a significant discovery. David had seen a plant matching the description of *Erica verticillata* growing at Protea Park in the South African city of Pretoria. The first living species had been found! In the next few years, after a world-wide search for the plant, specimens were tracked down from cuttings sent to the UK, USA, and Vienna. Later a surviving plant was found in an old area of Kirstenbosch where it had survived for over 30 years. From 8 serving plants, many cuttings were produced to diversify the gene pool, and from these 8 plants, a number of



specimens were planted in the wild. To be taken off the extinct list, the plant needs to go through three fire-cycles to prove its comeback and resilience in the wild. So far, the specie has gone through 1 fire-cycles in the wild. In time we hope for the species to be well adapted and thriving in native Fynbos once more bringing it back from the brink of extinction in the wild. The Kirstenbosch Botanic Garden team led by Anthony Hitchcock, have been so successful cultivating this species that the plant is now sold widely as a garden plant in Nurseries.
Other species of Fynbos are endangered and rare in the wild, such as *Jamesbrittenia bergae.* This delightful red flowering plant can be difficult to cultivate but puts forth a superb, red, carpet of flowers during the summer.

Cultivating species of Fynbos is an important work at Kirstenbosch Botanic Gardens. Cuttings from Restios, Geophytes, Proteas, and Erica and other species are rooted for mother stock plants and propagated for the display gardens, and for nurseries around the country. Research and work goes into developing ideal conditions in soil, and horticultural practices to ensure good growth and reliable plant stock, all of which Kirstenbosch is renowned for.

Above. Species of Restio in Cape Point National Park

Below Left - Right. Erica Species, *Erica nevillei*, and *Erica ericoides*

Above Left - Right. Erica species, *Erica cerinthoides, Erica verticillata*.
Below Left, Bottom left, Right, Bottom right. Geophyte Fynbos species: *Bobartia indica, Haemanthus sanguineus, Watsonia tabularis,* and *Agapanthus africanus.*

Above. Protea species in the Fynbos. Top left shows the post-fire recovery growth of the Ground Pincushion species *Leucospermum hypophyllocarpodendron.* This species grows close to the ground forming a dense ground cover. When flowering, many flower head adore the vegetation floor and is mouse pollinated. Above right shows the large flower of the King Protea which is South Africa's floral emblem. This Protea, *Protea cynaroides*, has large green oval leaves, with a red border along the leaf's margin. Lower left and right depicts the Giant Pincushion's flower and tree-like nature (*Leucospermum conocarpodendron*).


Above. A typical post-fire Fynbos region showing four typical species.

Left and below. Many Fynbos species can be successfully propagated from cuttings, or rootstock cuttings, while others work best from seed. During the field study of Fynbos, rootstock cuttings of *Staavia radiata* were collected for propagation and study at the Kirstenbosch National Botanic Gardens. Here we can see Anthony Hitchcock of Kirstenbosch Botanic Gardens demonstrating rootstock collecting for research and conservation. This work is very important and a vital part of the work at Kirstenbosch. Rare Fynbos plants are collected in the wild and propagated for mother stock, and preservation of the species.

# Kirstenbosch National Botanic Gardens

Kirstenbosch Botanic Gardens are situated on the southern slopes of Table Mountain National Park. This sheltered area, hosts a number of endemic species growing in the valleys and mid slopes of this mountain. Towards the lower parts of the mountain, the Botanic garden begins with a series of display gardens dropping away to the visitors centre and glass houses lower down.
The garden was founded in 1913 and planted with some exotic species, however over time the main focus began to be native species. Today the garden boasts a wide display of native South Africa species representing the entire flora of South Africa.


Left. The rare *Jamesbrittenia burgae* in flower at a display at the Botanic Garden.

Left and Below. A rare specimen of the Silver Tree *Leucadendron argenteum* growing in its native habitat endemic to Kirstenbosch Botanic Garden.

This Protea has been has been grown from cuttings, but mostly propagated from seed.

Conservation efforts are important at Kirstenbosch. Fynbos specimens are collected from the wild by the research team and propagated and displayed at the Botanic Garden. Threatened species are preserved in dedicated Threatened Species Stock beds outside of the garden displays and used for propagating for restoration projects a and to collect seed for the Millennium Seed Bank

Below. The research restoration Fynbos team headed by Anthony Hitchcock, collects and processes cuttings from native areas required for propagation. Anthony (right) demonstrates the process of heel and root cutting propagation collected from the field. The cuttings are dipped in a rooting hormone and planted in punnet. These are placed in mist beds in a sterile, moist environment until the cuttings have taken, then removed to another shade house.

Left. The shade house where many Protea and Erica species are kept after propagation.

Right. Restios kept in direct sunlight ready for planting.
Below left. Potting mix developed for Fynbos species. The mix tries to recreate the poor nutrient, and high drainage characteristics of the Sandy Table Mountain soils. Many species of Fynbos do not tolerate heavier soils.
Below right. Seed and cutting propagation kept in a warm, moist environment until rooting has fully developed.


Above. Overlooking Kirstenbosch National Botanic Gardens.
Below. An Orchid (*Disa ferruginea*) with Table Mountain visible in the background.

## Afterthoughts and Credits

Overall the experience of what South Africa has to offer, was amazing. There are many different practices in the Horticultural industry according to what works best for each business to ensure profitability and sustainability.
South Africans are very passionate about their plants and gardens, and this is reflected in the large Retail Nursery outlets that stock products from the Nurseries I visited. Presentation is always at its best in Retail. Prices are low as well, presenting challenges to be able to provide a product that sells but also covers costs and produces a profit.

Excellent presentation and attention to neatness and cleanliness is reflected in many gardens, especially in Kirstenbosch Botanic Garden. Kirstenbosch is a valuable asset to Cape Fynbos, and their continued work in regeneration, restoration, and conservation of Fynbos species, is critical.

The Cape Floral Kingdom is a very unique and diverse kingdom, and well worth the opportunity to visit in person. There is nothing quite like seeing the wonderful reds, blues, and yellows of Fynbos bursting out of the sandy Cape Mountain soils. This would be particularly beautiful in Spring.

*Many thanks for the information and opportunities presented by all people involved:*

*Anthony Hitchcock, Kirstenbosch Nursery, Living Collection and Threatened Species Manager. Fynbos Expert.*
*Monique McQuillan, Senior Horticulturist at Kirstenbosch Botanic Gardens.*
*Dr. Andy Hackland, Owner/Manager of Frontier Labs.*
*Judy Bucchianeri, Secretary at Frontier Labs.*
*Hans-Jurgen Sittig, Manager/Owner of Sittig's Nursery/Prime Genetics.*
*Hans Hettasch of Arnelia Farm.*
*All the staff at the Nurseries visited.*