WAGENINGEN UR
For quality of life

Seed germination methods for native Caribbean trees and shrubs

With emphasis on species relevant for Bonaire

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Summary

This paper is intended as a basis for nature restoration activities using seeds of trees and (larger) shrubs native to Bonaire with the aim of reforestation. It describes the main seed biology issues relevant for species from this region, to facilitate decisions on time and stage of harvesting, safe storage, breaking dormancy and germinating seeds and planting the young trees in the field.

The paper also emphasises that natural process of seedling establishment and succession must be observed in order to be successful. The choice of species and method of protection once planted in nature will prove essential.

The paper ends with stressing that such a reforestation activity needs to be planned far ahead: seeds must be collected from tree species taking care of genetic diversity and their storage potential. Recalcitrant seeds (see paper) must be treated carefully and in a different way.

In Appendix I all knowledge from literature about collection, storage, germination and planting has been collected. Appendix II gives the growth characteristics of a selection of trees.

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1. Introduction

The flora and vegetation of Bonaire have been and continue to be heavily influenced by introduced feral livestock and human activities, resulting in large degraded areas with a very low presence of the original vegetation (Debrot & De Freitas, 1993; De Freitas *et al.,* 2005). These areas are especially prone to erosion and have great difficulty in restoring their original composition and structure. This often results in shrub lands with exotic species dominating the shrub and tree layers (Brandeis *et al.,* 2009). The cumulative impact of deforestation by man and his introduced grazers is also the endangerment of many tree species that cannot regenerate due to low seedling production and survival.

To re-establish the natural biodiversity and heed certain species from local extinction, nature needs some help by planting native trees and shrubs. These however are not readily available. Landscapers either have no interest in producing certain species, for instance because they are not suitable as garden elements and have no market interest, or they are not able to produce them either for lack of material for propagation or lack of knowledge about propagation methods.

Successful reforestation depends on several factors and issues which need to be addressed. These include:

- The exact purpose of the reforestation,
- Which species to plant to fulfil these purposes,
- The availability of viable propagation material,
- Successful germination and production of young plants,
- Determining when where and how to plant and how and how long to care for these (e.g. Debrot, 2013).

One of the greatest limiting factors and challenges to reforestation efforts in recent years has been the shortage of young plants of suitable species. In this, the key problem has been that of poor germination of collected seeds. Whilst various initiatives are presently underway ttowards larger reforestation efforts in the Caribbean Netherlands, the purpose of this report is to address the issue of seed germination. This is done by compiling available information on germination techniques and available knowledge about and potentially applicable to the tropical species of relevance to reforestation in the Caribbean Netherlands.

Trees have developed many strategies for their seeds to overcome the harsh conditions during dry periods. These include very thick seed coats or pericarps, chemical regulation of seed dormancy (inhibitors), hormonal regulation of dormancy, special light requirements, rudimentary embryos that need a certain period of maturation, etc. Other species have seeds that cannot be dried or stored and need to be planted immediately (so-called recalcitrant seeds).

Ray & Brown (1995) experimented with 10 species from Puerto Rico and the Virgin Islands, some of which are in common with or comparable to species from Bonaire, and had great difficulty in getting the seeds to germinate. Very often scarification (filing off of part of the pericarp) and/or stratification were needed for longer periods. Germination of many took several months or they did not germinate at all.

For reasons of maintaining or improving biodiversity, seeds are to be preferred: they have an inherent genetic variation: every individual generated from seed is genetically unique. This is impossible to obtain with cuttings and graftings. Disadvantage of most seeds from the arid tropics, however, is their dormancy. Almost all seeds need a special treatment to start germination.

This document summarises the current state of knowledge of seed treatments relevant for tree and shrub seeds of species native to the Caribbean Netherlands, with emphasis on the species from Bonaire. However, for many of these species no germination data are available. In such cases, the best we can do is to try to deduct the best possible method from experiments with related species and use this as a basis for field trials.

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2. Seed biology

Seeds show an enormous variation in structure and shape and a large variation in germination behaviour. The most relevant sources of this variation are treated in this chapter.

2.1 Types of seed structures

The term 'seed' covers all kinds of different structures: true seeds, (parts of) fruits, flowers with fruits inside, grass florets, etc. When we restrict ourselves to the Angiosperms, the flowering plants with true seeds, seeds that develop in a closed fruit. This is the case for all trees and shrubs in Bonaire (Figure 1). The fruit contains one or many seeds.

2.2 Types of storage behaviour

For successful germination experiments, it is important to know the storage behaviour of the seed. For one thing we must ensure that if we collect and store the seed we do it in such a way that the germination capacity is not affected; secondly, the storage type also dictates the time when to plant and the way how to plant.

Roughly, seeds can be grouped in orthodox and the so-called recalcitrant seeds, although also seeds with an intermediate type exist. The orthodox seeds can be dried and stored for longer periods, say a couple of years and will germinate normally when planted. In contrast, recalcitrant seeds can not be dried and must be planted immediately. Well-known examples for orthodox seeds are most crop and weed seeds (cereals, maize, lettuce, cabbage, etc.). Recalcitrant seed we normally find in fruit crops (avocado, litchi) or trees of the tropical evergreen rain forest.

Some seeds can be dried and stored just for a limited period, the intermediate type. Examples are neem, *Azadirachta indica*, seeds and *Citrus* seeds (Table 1).

Table 1. Types of storage behaviour of tree and shrub seeds, suggested ways of dormancy breaking, and suggested germination methods.

Storage behaviour	Examples	Dormancy breaking	Germination method*
Orthodox, no dormancy, small seed	*Solanum*	1. Not needed. Seeds may be soaked prior to planting. 2. Some species benefit from 0.2% KNO_3 instead of pure water. 3. Some species (esp. cereals) benefit from a 0.02-0.1% GA_3**.	Sow directly on top or between paper.
Orthodox, no dormancy, large seed	*?Mirabilis, Zea mays(!)*	–	Sow in sand or sand/compost mixture.
Orthodox, hard-seeded	*Acacia(!), Albizzia(!), Cassia(!), Prosopis(!),* some *Myrtaceae(!)*	1. Clip or file off part of the distal end or piece seeds; larger seeds can be cracked 2. Soak for up to 1 h in concentrated H_2SO_4, until seed coat is pitted, then rinse thoroughly in running water (see text for safety instructions!).	After method 1: soak for 3 h, then sow on top or between paper.

Storage behaviour	Examples	Dormancy breaking	Germination method*
Orthodox, mechanical inhibition	*Prunus(?) and other seeds ('kernels') from stone fruits, Pterocarpus(!), some Terminalia(!), Melia volkensii(!)*		Sow in shallow germination beds of a mixture of sand and compost. Cover with wet gunny bags or a thin layer of sand. Keep moist until emergence. Protect against direct sunlight.
Orthodox, chemical inhibition	*Beta(!)*	Soaking in water for 2-48 h with repeated intermediate rinsing.	Sow between paper or in sand depending on size.
Orthodox, chemical and mechanical inhibition	*Tectona(!)*	Soak in water for 12 h, dry 12 h; repeat during 10-14 days.	Sow in shallow germination beds in a mixture of sand and compost. Cover with wet gunny bags or a thin layer of sand. Keep moist until emergence, then remove cover and water regularly. Protect seedlings initially against direct sunlight.
Orthodox, physiological inhibition (immature embryos)	*Arecaceae* (Palms) *(!)*	File off part of the endocarp, drill or pierce. Disinfect to avoid rotting during the usually long germination.	Sow in sand or sand/compost mixture; either in the lab or as above.
Recalcitrant	Litchi, water apple, avocado	Soak in water for 24-48 h, cut off at distal end and remove pericarp or hard seed coat if present. Wash the seed and treat against fungi.	Sow in sand or sand/compost mixture.

* *Temperature in lab equipment preferably alternating between 20 and 30 C (see text) or ambient when outside or in screenhouse.*

** *More dormancy breaking methods, including gibberellic acid (GA_3) treatment can be found in ISTA (2014).*

2.3 Seed collection

When harvesting seeds, they should be mature. This can be seen from the fruit colour, the colour of the seed itself (usually not white or green), the fact that they fall off the tree, etc. But still then, some seeds may be more mature than others, explaining in part why they often do not germinate all at the same time. This difference in maturity often disappears after a period of one or two months of dry storage. We call this after-ripening, and may also include the lifting of physiological dormancy (seed 2.5 Dormancy).

Keeping or improving biodiversity

Regeneration of natural stands is preferably done with seeds: they have an inherent genetic variation which can be increased by collecting form different trees at different sites. When collecting branches for cutting and grafting purposes, one must especially pay attention to collect from many different individuals.

Orthodox seeds can be collected in paper or cotton bags and transported indoors at the end of the day. Direct sunlight and excessive heat (in the booth of a car) must be avoided. In many species, the seeds can not be collected as such, but are still contained within a wet or dry fruit.

In case of wet fruits, like berries, the seeds have to be extracted from the fruit pulp or juicy tissue and thoroughly washed to remove all material that may serve as medium for fungal growth. If the seeds remain surrounded by a jelly-like substance, then a treatment with hydrochloric acid (HCl) may be necessary (common practice in tomato seed production). Then a small amount of commercial HCl is added to the extracted fruit pulp and left for about half an hour. Quantities and time depend on the species and must be experimented.

In the case of dry fruits, it usually suffices to dry the fruits in paper or cotton bags, so that they will open by themselves. Examples are fruits of the Meliaceae *(Cedrela, Swietenia)* and Bignoniaceae (*Spathodea, Tabebuia, Tecoma)* with their winged seeds and the Asclepiadaceae (*Calotropis*, *Cryptostegia*) and kapok with their seeds with long hairs. These extra structures are best removed before planting.

Some dry fruits do not open by themselves (*Tamarindus indica, Acacia nilotica, Prosopis juliflora*). These have to be opened by force.

Seeds may also carry arils: appendages on top of the seed. These may inhibit germination by blocking the entrance of water as well as by containing inhibitory substances. This was found in *Trichilia emetica, Afzelia xylocarpa* and *Sindora siamensis* (Pukittayacamee, 1990; Masanga & Maghembe, 1993). Removal of the arils largely lifted the dormancy.

For a list of seed extraction methods see Table 2 based on Schmidt (2007).

Table 2. Fruit types and methods of extraction.

Fruit type	Examples	Extraction method
Dry dehiscent pods and dry follicles (1 or 2 carpels)	*Albizia, Calotropis, Cryptostegia, Leucaena, Spathodea, Tabebuia, Tecoma*	Dry in paper or cotton bag to release the seeds. One may need to assist manually. Remove arils if present.
Dry indehiscent pod	*Acacia nilotica, Cassia fistula, Prosopis juliflora, Tamarindus*	Opening by force. Some of the species have seed with an aril or similar which need to be removed. Rinse sticky seeds thoroughly and surface dry on filter paper. Subsequent exposure to low (ambient) relative humidity or artificial drying (see drupes).
Capsules: dry fruits opening with slits or pores	*Cedrela, Eucalyptus, Spathodea, Swietenia*	As dry dehiscent pods.
Cones and compound dry fruits	*Casuarina,* Pines	As dry dehiscent pods.
Drupes (fleshy fruits with one seed)	*Mangifera, Prunus, Persea*	Direct extraction or softening the fruit by fermentation; subsequent rinsing, surface drying on sheets of paper and subsequent slow drying with forced ventilation or in a low temperature oven (30-40 C). Note: seeds of this group are often recalcitrant and need to be planted directly after extraction. Only surface drying.
Berries (fleshy fruits with multiple seeds) and compound fleshy fruits	*Guajava, Annona, Arthocarpus*	As drupes.

2.4 Seed storage

Orthodox seeds may still need some extra drying if they need to be conserved for a longer period (over a month). For short periods they are best kept in paper bags: these allow for extra moisture to escape. The bags have to be kept in a dry and cool place: below 30 C and below 50% relative humidity (RH). To determine whether the seeds are really dry, the bags shall be weighed daily and when they don't lose weight any longer, the seeds may be transferred to plastic, or better, laminated aluminium foil bags (the type commercial vegetable seeds are packed in). Tins and glass jars are also very suitable. The bags may be kept in glass jars at room temperature, or better still in the fridge at around 5-7 C.

Orthodox seeds, if dried in equilibrium with 30 relative humidity or lower, can be stored at sub-zero temperatures. -20 prolongs the longevity of these seeds with years, even decades.

Insect damage is very common in seeds: it already starts at the trees, so one has to try to stop them from eating all seeds when in storage. Insects get slow at low temperatures, so always store the seeds in air-conditioned rooms. One may even kill them off by putting (very dry) seeds at -20 for 48 h in airtight containers.

Note that if seed bags are removed from a cool place, condensation on the seeds or paper bags with seeds must be avoided. At all times, bags from cool storage have to be left closed to acquire room temperature for one or two hours depending their volume before they are opened. Otherwise moisture will condense on the seeds, reducing their viability. This is especially important if the remainder of the seed is to be transferred back into storage.

Recalcitrant seeds are best collected in the fruit, stored for maximum one week as long as the fruit is not rotting. At planting they are best removed from the fruit, washed and immediately planted. Such seeds also do not tolerate low temperatures, so there is no way to keep them longer. Fortunately most trees and shrubs of Bonaire have orthodox seeds. Appendix I indicates the storage behaviour if known.

2.5 Dormancy

Although most seeds in Bonaire are orthodox, this does not mean that they germinate easily. On the contrary: the seeds are very well adapted to the dry conditions and have a built-in protection against drying out and premature germination. This is called dormancy (Bewley 1997). There are various ways seeds overcome dormancy. We will review the most relevant methods.

2.5.1 Mechanical dormancy

Many seeds have a very hard seed coat or pericarp, like in the legume family (*Fabaceae, Caesalpiniaceae, Mimosaceae*). These seeds show so-called hard-seededness: although some seeds may take up water and swell, 'imbibe'), others do not allow the water to enter and remain as they are: they remain hard, while the others become more soft.

In nature this hardseededness is overcome by the a combined action of rain, sun and the workings of micro-organisms. In some cases a form of acid scarification occurs when seeds are swallowed entirely by animals and later leave the animals intact.

One may break this type of dormancy in several ways: by mechanical scarification (piercing, filing and cutting), acid scarification, and stratification.

Mechanical scarification

Mechanical scarification is done in special rotating drums lined with an abrasive such as a carborundum (silicon carbide) or with brushing machines. Several other methods exist, including impaction, friction, heating, burning.

Manual methods consist of piercing the seed with a needle or nail, to clip or file off part of the seed coat, or to carefully crack the seed. These operations are not without risk and one must avoid affecting the area of the root tip. Most often this means treating the opposite side, the distal end. So one first has to open up one seed to determine the exact position of the embryo and root tip. In case the embryo makes up all of the space (endosperm is contained within the cotyledons), then it is often unavoidable that the tips of the cotyledons are removed in the action. This poses no problems in germination usually.

Acid scarification

The only acid that can be used effectively on hard seeds is concentrated sulphuric acid at a maximum concentration (96%). It is a very dangerous and abrasive chemical that needs to be used with great care and knowledge of the safety rules (Schmidt 2007, p. 224). **One has to ware safety glasses, gloves and other protective clothing and use a fume cabinet if possible. Inhaling the fumes is very harmful.**

The method consists of putting the acid in a glass or plastic beaker. The seeds need to be dry and are added to the acid for shorter or longer periods. The acid is then drained and the seeds are carefully poured into a large bucket with excess water.

Note: never put water in the acid and never put water on the seeds that are still wet from the acid: instant boiling will occur with dangerous mini-explosions of the acid!. If acid is spilled on natural materials skin, wood, clothes, then repetitive rinsing is needed to avoid burns and holes: the water will evaporate leaving the acid more and more concentrated, ruining your clothes.

The acid may be used several times, but its effectiveness will gradually diminish. Store the acid in clearly marked bottles out of reach of unauthorised persons. Preferably in a fume cabinet.

Table 3. Sulphuric acid treatments to overcome hard-seededness in some legume seeds (based on Schmidt 2007, p. 226).

Species	Duration (min)	Germination (%)
Albizia lebbeck	40	85
Caesalpinia spinosa	60-240	100
Cassia sieberiana	45	90-95
Cassia fistula	45, 90	Resp. 75 and 84
Ceratonia siliqua	20	89
Cornus capitata	5	70-80
Delonix regia	180-360	?
Erythrina abyssinica	5-20	?
Leucaena leucocephala	30	95
Prosopis alba	6-24	100
Prosopis flexuosa	6-24	100
Prosopis chilensis	6-24	95
Prosopis tamarugo	6-24	95
Prosopis juliflora	15-60	95-100
Senna bicaparis = bicapsularis?	60	95-100
Senna didymobotrya	60	95-100
Senna multiglandulosa	60	95-100
Senna occidentalis	60	95-100
Senna septemtrionalis	60	95-100
Senna siamea	15-45	98
Vachellia nilotica(=Acacia n.)	> 15	?
Vachellia tortilis (=Acacia t.)	30-120	100

Heat treatments

In many Leguminosae, 'legumes', dormancy can be broken by putting the (intact!) seeds in boiling water, extinguish the heat source, and leave the seeds in the water until it has cooled off. Dry heat of 100C for between (5-)10 and 30 minutes may work equally well. Bowen & Eusebio (1981) successfully broke dormancy in this way and obtained up to 83% germination in *Acacia mangium* seed. Of course each seed and harvest may react differently, so some prior experimentation is always needed.

Stratification

Finally, there is the possibility to mimic nature and put the seeds under certain environmental stress. It is quite common practice in temperate regions where the seeds are kept, often buried in the soil, under cold and wet conditions so that microorganisms can break down the seed or fruit coat. Temperatures are best kept below the minimal temperature for germination. In tropical areas this method is not used very much, because many seeds do not withstand the low temperatures for prolonged periods of time. A disadvantage is also that it normally takes months before the seeds can be put for germination.

2.5.2 Chemical dormancy

The seed coat, or more often, the fruit coat (pericarp) may contain inhibitory substances. In nature these are gradually washed out enabling germination after a certain period or successive periods of rain. In order to germinate such seeds it is recommended to soak them in ample tap water for 24 h, surface dry them and plant them in the

medium. If this fails, successive washings may be necessary. One can sometimes have an indication, because coloured substances may come in the water. Then it is best to continue until no discoloration occurs. In that case cycles of 8 h or shorter may be more effective.

Note: anoxia (lack of oxygen and consequent dying of tissue) may occur when seeds are soaked for more than 24 h. Changing the water regularly, running water, or aeration are possible solutions.

Teak is probably an example of a combination of mechanical and chemical dormancy. Germination of the seeds involves pretreatment to remove dormancy arising from the thick pericarp. Pretreatment involves alternate wetting and drying of the seed. The seeds are soaked in water for 12 hours and then spread to dry in the sun for 12 hours. This is repeated for 10–14 days and then the seeds are sown in shallow germination beds of coarse peat covered by sand. The seeds then germinate after 15 to 30 days (Kadambi, 1972; Robertson, 2002).

2.5.3 Physiological dormancy

In some plant families, most notably the palms, the embryo is still rudimentary when the seed is mature. Palms also have a very thick and hard pericarp and the combination of these make it very hard to germinate them within a reasonable time. After scarification and wetting the seeds it may still take months before germination starts. *Ilex paragaiensis* seeds for instance, have only 1% mature embryos, the others take 5-9 months under appropriate environmental conditions to reach this stage (Fontana *et al.,* 1990).

2.5.4 Photodormancy

Seeds sometimes require specific light conditions to germinate, esp. regarding the spectral composition of the light. In nature this can be observed when seed do not, or conversely do only germinate in the shade: the ration of red to near infrared determines their behaviour. Many humid tropical species have this property, e.g. *Spathodea,* some *Eucalyptus*. In the lab a day-night cycle with ample light may overcome this type of dormancy, esp. when the light contains relatively much red light.

2.5.5 Thermodormancy

Some species (e.g. *Lactuca*) go into dormancy at too high temperatures. In the tropics many species require grass or bush fires before they will germinate, e.g. *Proteaceae, Eucalyptus* (Schmidt, 2007). Mimicking such conditions is hard and usually risky, but one may try to expose the seeds to high temperatures in an oven. The maximum safe temperature would normally be 70 C. Mechanical scarification may overcome this type of dormancy too, but for the tiny seeds of *Eucalyptus* this is no option.

2.5.6 If everything fails…

If everything fails this may be due to a number of reasons: often the seeds were empty from the start; other seeds may contain diseased embryos. This can be checked by X-ray or opening up some of the seeds by force. Separation of good and bad seeds is often possible by flotation: the good seeds will usually sink in water. This is especially suitable for the larger seeds, the size of a cherry pit or larger. In commercial companies small seeds are separated in this way with air. In labs this type of separation is done with small scale seed blowers.

The seeds may be perfectly viable however, which can be established with the tetrazolium test (ISTA, 2014). In such cases embryos may be excised and germinated under sterile conditions on artificial growing media. This last resort to '*in vitro* culture' demands special facilities and expertise and will not be considered here. In such cases it is better to choose methods of vegetative multiplication, like cuttings.

2.6 Germination methods

2.6.1 Location

For commercial seed trade, seed tests are exclusively performed under laboratory conditions using special seed germination equipment (Don 2013, ISTA 2014). In everyday practice of plant production, seeds are normally sown under controlled conditions in greenhouses or, less controlled, screenhouses. Under high solar radiation, the greenhouses may become too hot, while the temperature in screenhouses will be lower but can not be controlled. After the initial germination, seedlings are transplanted into polybags or full soil and raised out in the open, but always under shade. Before planting in 'the wild' these seedlings may undergo a special treatment (making stumps, disinfection, and hardening).

2.6.2 Media

A number of media can be used to germinate seeds successfully; they all have their own specific uses.

Filter paper

Small seeds are usually best germinated under very controlled conditions. Wet filter paper in the form of paper circles or as rolled sheets provide a more or less sterile environment for these vulnerable seeds. The paper circles are placed on a sheet of wet filter paper and put in a closed box provided with a preferably transparent lid.

Sand

Seed of the size of a cereal grain or larger are best sown in sterile course river sand or a mixture of sand and compost. Sand and compost have the advantage of a buffering capacity: the seeds are isolated from each other and especially the soil may counteract the possible pathogens on the seed. Soil is not advised, because it will contain many diseases. If one is not certain about the sterility of the medium it shall be sterilised with an autoclave or pressure cooker.

The medium is half-filled in a box onto which the seeds are put. The seeds are then covered with a layer with a thickness of about 3-5 times the size of the seed (Figures 1 and 2).

Figure 1. Germination rack with large 'favorietbakken' with transparent lid.

Figure 2. Seedlings growing in a germination cabinet using boxes with transparent cover.

Polybags

After initial germination, the young seedlings are usually transplanted ('pricked out') into a larger container consisting of a black tubular pvc bag filled with a mixture of clay, sand, burned rice husks and some fertilizer. These are placed on the raised bed onto the bare soil.

Advantage of these bags is that they provide easy handling of the seedling, e.g. to increase the spacing after some time. Very often the tap root will penetrate in the underlying soil and will have to be cut.

Figure 3. Nursery using 'polybags'.

Plain soil

Seeds, especially the larger ones, can be sown directly in beds of plain soil, improved with humus (compost) and fertilizers. Normally the seeds are sown close to each other and covered with a thin layer of sand or soil plus mattings of straw or palm fronds to keep the moisture. As soon as germination starts, the mattings are removed and the soil is kept moist through watering. After germination also these seedlings have to be moved to the poly bags to avoid deep rooting and entangling roots.

Figure 4. Raised bed with seed planted in plain soil.

Water quality

It is best to use clean tap water with a pH within the range of 6-7.5. This can best be determined in the media itself: so in case one uses sand or soil, a wet mixture is made and the pH checked with litmus paper. Use of water from natural sources, surface water form ditches, is strongly advised against because they contain many sources of seedling diseases, so that once the seedlings have emerged they will be attacked and die. Seedling mortality is one of the major sources of disappointing results.

Temperature and light

Seeds generally germinate better when grown with a day-night cycle for temperature and light, with the high temperature during the day (e.g. 30 C for 8 h) and the low temperature during the night (20 C for 16 h). These temperatures can both be raised by 5 C. The light is no requirement initially (the seeds are often buried anyway) but they may stimulate germination in some cases and give more compact and sturdy seedlings. As soon as the seeds have germinated and show their cotyledons, it is necessary to give enough light to prevent elongated and more sensitive seedlings.

2.6.3 Disinfection

In order to be certain that fungi will not spoil the seed or seedling it is advisable to treat the seed with a fungicide. This is especially valuable for seeds that take a long time to germinate (over 2 weeks) and recalcitrant seeds. Such a treatment will consist of powdering the seeds with thiram. This can be done by shaking the seeds in a glass bottle together with the chemical: an even powdering is essential. Protect yourself with surgical gloves and a mouth cap.

2.7 Protection of the seedlings in the nursery

Although the mature trees will usually grow well in full sun, their seedlings need special care. In nature seedlings emerge on the forest ground where some shade and moisture will be present. . Plants actually differ greatly with respect to their requirements for seedling survival. Typically seedlings of early successional pioneer plants good for erosion control (e.g , grasses, and *Vachellia tortuosa*) and beach dune vegetation species (e.g, *Scaevola, plumieri*, *Mallatonia gnaphalodes*) have much greater tolerance to high light levels than mature forest hardwood species that are typically the focus of reforestation because of their rarity (*Myrcia curassivica*) and or fruit production (*Jaquinea arborea*). Apart from that, a large number of dangers and enemies are fond of juicy seedlings and young plants.

Sun and temperature

Temperatures shall not reach beyond 30 or max 35 C. Some seeds go into dormancy at high temperatures and seedlings suffer from the heat. Direct sunlight must be avoided during germination and early seedling growth; seedling may burn and whither. In the lab sunlight and high temperatures are no problem, but they are in green-houses and screenhouses. These must therefore have provisions for shading. This is especially needed when seedlings have just been transplanted, with or without root trimming. Seedbed and beds with young transplants have to be shaded as well. Usually a temporary provision with matting, palm fronds or shading nets is enough.

Rain and wind

Seeds and young seedlings shall be protected from rain and wind. These may physically damage the plants and the splashing mud may introduce bacterial and fungal diseases.

Rodents (and leguanas?)

Rats and mice are fond of seeds and young seedlings. If necessary, take preventive measures, such as traps, raise the plants in a screenhouse or greenhouse with at least the lower 1 m consisting of glass walls and anti-rodent collars.

Birds

Birds, esp. doves, pigeons, crows, are also notorious seed and seedling eaters. Protection is usually needed until a mature seedling stage. Nettings are sometimes needed, but have the disadvantage of hampering the daily care and twice-daily waterings.

Slugs

Slugs must be eliminated withal means possible: they can destroy a whole seedling bed in one night. Slug pellets based on nematode infection, like Escar-Go™, are safe for humans and all other animals.

Insects

Many types of insects appreciate seedlings and young plants, esp. the young leaves. Spraying with insecticide may be needed occasionally. Netting against butterflies is effective but hampers the watering.

Diseases

Because the seeds are collected from the wild, all kinds of pathogens may be present on and in the seeds. The pathogens on the outside of the seed or from the soil, may attack the initially healthy seedling; it falls over. This is the so-called ‘damping off’ of seedlings. Therefore preventive treatment of the seed with a fungicide like Thiram™ is advisable (see 2.6.3 Disinfection).

2.8 Nursery design

Nurseries are places outside in the open where seedlings are raised until they reach a stage that they can be planted out in gardens or in the wild. Still, seeds and seedlings need protection against the elements, predators and diseases.

The best location to establish a nursery is between hedges and buildings of up to 2 m high: high enough to prevent strong drafts and wind and low enough to profit from morning and afternoon sun.

The soil should be free from weeds, because even if removed, their germinating seeds may be a nuisance for years. If necessary weed cloth may have to be put underneath the raised beds.

Beds are typically some 10 cm above the paths, 1 m wide to enable easy manual care, and may be of any length. Ideally they are located on a gentle slope, so that pools during heavy rains are avoided. The sides may be stabilised with bamboo, wooden planks or stones .

The seed beds shall be free from other seeds, i.e. established from commercial sand and gardening compost, commercially available nursery soil, or sterilised material of own composition.

Large seeds are planted in shallow furrows made across the beds (Figure 5), smaller seeds are broadcast, and very fine seeds are first mixed with dry sand to avoid sowing them too closely.

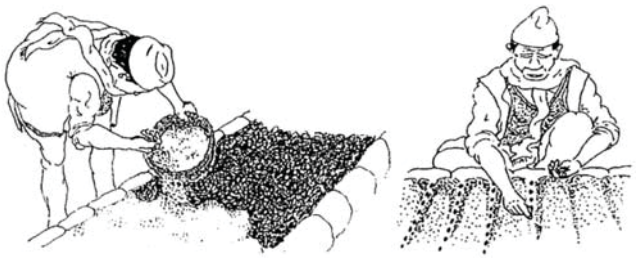

Figure 5. Working with seedbeds (CTA 2007).

Shading is best provided by an overhead roof made of bamboo mats. To this end a frame is constructed along the sides of the beds to enable the bamboo mat to be rolled out or rolled up at convenience or to regulate the light (Figure 6). Beds and their shades are best positioned in an east-west direction, to maximally protect the seedlings from direct sun. The shades also protect against excessive rainfall.

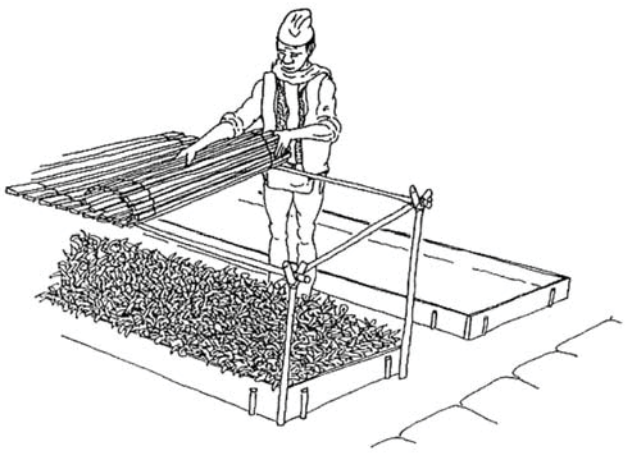

Figure 6. Frame and bamboo cover over the seedbed (CTA 2007).

2.9 Seedling establishment in the field

Depending on the species, one may decide to use one of three of the most common methods: direct seeding, transplanting early seedlings, or transplanting 1 or 2 year old 'seedlings'.

Direct seeding

Direct seeding means putting non-germinated seeds on ('broadcasting') or into the soil. This is possible for species that readily germinate (within 1-2 weeks) and when they can benefit from a period of steady rain and moisture. Certain pioneer species belong to this group as well as most weeds.

Transplanting of seedlings

For the majority of species however, we have to break dormancy and raise seedlings under controlled conditions (see 2.6. Germination methods above). They are usually germinated under controlled conditions, then planted out in polybags and raised until some dm length. Then transferred to their final place in nature in carefully planted and nurtured afterwards (see next paragraph).

Figure 7. *Seedlings of the rare endemic Maytenus versluysii in the shade at the Carmabi nursery, Curacao, December 2009.*

Planting stumps

Stumps are seedlings of a few months up to 1-2 years old from which part of the roots and shoot have been cut. Trimming of the roots enables planting it straight into the ground, while trimming the shoot is necessary to avoid excessive evaporation during the early stage out in the field, because the roots are not effective yet. Stumps can be prepared a few days before planting. In that case they are best kept bundled and in a moist gunny bag, with the leaves sticking out. To avoid bacterial growth or rotting this period moisture should be kept low and the period kept short, i.e. maximum 4 days (Chacko *et al.* 1990).

The success of stump planting varies considerably between species, some just don't tolerate being trimmed.

Seeds, seedlings or cuttings?

It is recommended to start from seedlings: seedling with good tap roots are essential for early establishment and rapid reaching of underground water, rendering them drought-tolerant in the shortest possible time. We already mentioned the genetic benefit of using seeds.

Annex 1 provides an overview of the knowledge on seed storage behaviour and germination methods, as well as indications of the drought tolerance of the various species in view of their chances of survival in the field.

2.10 Clearing, planting, watering and care in their final destination

Clearing

Before planting, the intended planting spot must be cleared from other plants in a circle of about 1 m diameter. The soil is best turned over with a spade.

Planting

Planting can be done in 'crow bar holes', made by sticking a firm planting stick into the ground. This is often done with stumps. A shallow pit around it will enable effective fertilisation and watering.

Larger plants with a bundle of roots need to be planted in a spacy planting hole, which will first be filled up with water and after drainage the seedling is placed in the hole with the roots spread out downwards at 45 angles and the hole filled up with a rich moist mixture of sand, compost and fertiliser. The area around seedling will be depressed to form a shallow pit for easy watering. If the seedling is still in the polybag, then the bag has to be removed while the clump of soil and roots is kept intact as much as possible to prevent damage to the fine side roots. The whole clump will then be carefully planted.

Figure 8. Transplanting seedlings: how it should be done: Elsmarie Beukenboom (Stinapa) together with thriving saplings of Erithalis fruticosa, lumbra blanku, (on her right) and Maytenus versluysii (on her left) planted in the confined shelter of trees bushes and rocks, Klein Bonaire, June 2013.

'When planting, it is important to keep in mind that plants have different and sometimes more or less stringent soil requirements (Stoffers and Mansour Alassiass 1967). Some need acidic soils (e.g *Myrcia curassavica*, rare endemic) while others may or may not thrive depending on excess humidity, presence of salt, carbonate rock, sandy or clayey soils. Therefore, careful site selection is important to optimize results. Wakkee *et al.* provide some data (Appendix III), as well as Stoffers and Mansour Alassiass 1967.

Care

Ray and Brown (1995) demonstrated in Puerto Rico and the Virgin Islands that a temporary provision of 'medium shade' increased seedling survival in the wild of some species increased from 0% to about 50%, while the survival of other species increased from around 65% to 95%. Another group performed intermediately.

Depending on the climate, and in all cases during the initial days and weeks, frequent visits will be needed to check on the plants, to water them and to remove surrounding plants that may compete with it. This weeding must be done at least three times during the first year; after that and depending on the size of the seedling, this frequency may be reduced until the young tree can manage by itself. Even then shovelling the soil around it will improve its development, by reducing competition for rain water and nutrients.

Figure 9. How it shouldn't be done: Dead sapling planted in dry, wind and sun-exposed spot, June 2013.

3. Important considerations regarding the choice of species and their possible impact on biodiversity

3.1 Species composition and biodiversity

Species choice must reflect natural assemblies as defined by Stoffers 1956 and De Freitas *et al.* 2005. In natural vegetations we may define the pioneers ('early successional species') who establish themselves rapidly and form a cover for the slower germinating and/or growing species which may remain understory trees or that eventually will emerge as the final dominant trees. These, together with what is growing underneath, the undergrowth or understorey, is the so-called climax vegetation (composed of 'late successional species').

Simply planting species from the climax vegetation may not be a good strategy, because the final climax species often if not always need shade for their germination and early development. McLaren & McDonald (2003) experimented with 4 climax species and found that survival in the sun, especially during the dry season was very low. Partial shade reduced seedling survival already significantly. Only full shade provided the ideal conditions for these seedlings to survive and establish themselves. Ray & Brown (1995) experimented with 10 dry-forest species and compared shaded and unshaded plots. The seeds were broadcasted, buried or seedlings were planted. In most species shading improved seedling survival, while in some species shading proved to be the critical factor for early survival.

This may mean that it is better to follow the natural course of events and start with a pioneer vegetation that could provide a cover for the more climactic species. This should preferably consist of native pioneers, but not necessarily so. With non-native species one runs the risk of introducing an invasive species. But even then, in due time native species may become part of the ecosystem, resulting in hybrid alien-native species forests (Brandeis *et al.* 2009, Cusack & Montagnini 2004, Parrotta 1995). The latter have studied old experimental plantations consisting of different species and the regeneration of understorey woody plants. They found that this depends for a large part on the canopy species, in some cases leading to successful understorey diversity.

So the strategy can consist of establishing a pioneer forest which will gradually be enriched by seeds of late successional species introduced by birds and rodents from the surrounding areas and from some occasional large seed bearing trees in or around the area (Chadzon 2013). To speed up the process, or in absence of mother trees in the surroundings, one can introduce seedlings and young trees through intentional planting. González-Rivas *et al.* (2009) suggest that *Guaiacum sanctum* could be used for reforestation of degraded sites, especially due to its rapid germination (about 6 days at 25 C) and high survival rate (80%) in open situations.

3.2 Choice of species

Of course one would prefer pure native stands, but then one has the problem of defining these, and we have to distinguish between stages of development, not just the climax vegetation. All vegetations on Bonaire are directly or indirectly affected by human activity. There are no examples of pristine forests or other vegetations that can serve as an example.

There are several clues however which can help us: 1. vegetations on neighbouring islands may show large similarities, like the vegetation of Curacao as described by De Freitas *et al.* (2005); 2. historical data based on early reports about the observed vegetations, like early floras (Boldingh 19..) describing what is native and what not, and other floristic literature; 3. archaeological data, like those provided by Jiménez (2007). The last approach only gives clues to species which leave clear archaeological traces, typically woody parts and hard woody seeds (Table 4 shows the species found for St Eustatius, Nevis and St Martin). Unfortunately such data are not available for the

Windward ABC islands. Many of these species we have in common in the present day, so may be regarded as indigenous.

For the Leeward part of the Caribbean, more data are available. Brandeis *et al.* (2009) provide an extensive list of native and introduced species for Puerto Rico and the Virgin Islands. Online databases like 'Plants of the Eastern Caribbean' , 'The Plants of St Lucia' and the 'Flowering Plants of Saba' give indications whether plants are native or introduced. Finally the Germplasm Resources Information Network (GRIN) provides this information as well as the most up-to-date nomenclature.

Table 4. Archaeological finds from locations (Windward Islands) of 550 BC to 870 AD (Jiménez 2007).

St Eustatius	*Nevis*	*St Martin*
Celtis iguanaea	*Amyris sp.*	*cf Annonaceae*
Croton nitens	*Bourreria sp.*	*Caesalpinia sp.*
Erithalis fruticosa	*Coccoloba sp.*	*Celtis sp.*
Guaiacum officinale	*cf. Eugenia*	*Guaiacum sp.*
Maytenus/Rhacoma	*Guaiacum sp.*	*Malvaceae*
Piscidia carthagenensis	*Hippomane mancinella ?*	*Sideroxylon sp.*
Piscidia piscipula	*cf. Manihot esculenta*	*Maytenus sp.*
Rubiaceae	*Sideroxylon sp.*	*Poacea sp.*
Dipholis sp.	*Maytenus sp.*	*Portulaca sp.*
Suriana maritima	*Piscidia sp.*	*Sapotaceae*
Zanthoxylum 2 spp.	*Zanthoxylum sp.*	*Verbena sp.*

Proposed species

For the project a balance must be struck between the ideal composition and what can be collected, germinated, raised, planted, and successfully established.

Figure 10. Rocks used to conserve moisture and protect roots from heat in a sapling Cynophalla hastata (palu di lora), planted at Pos Nobo, Slagbaai, June 2013.

The following is a list of native species that are candidates for restoration on Bonaire (Table 5). Most provide shade and shelter for animals, and lower story plants including seedlings, many provide berries that are eaten by birds, rodents, insects.

Table 5. Candidate species for nature restoration on Bonaire.

Amyris simplicifolia	*Guaiacum sanctum*
Bourreria succulenta	*Guapira fragrans*
Bursera karsteniana	*Jacquinea arborea*
Bursera simaruba	*Krugiodendron ferreum*
Bursera tomentosa	*Malpighia emarginata*
Capparis flexuosa	*Manihot cartaginense*
Capparis hastata	*Maytenus tetragona*
Capparis indica	*Maytenus versluysii*
Capparis linearis	*Metopium brownei*
Capparis odoratissima	*Myrcia curassavica*
Capparis tenuisiliqua	*Psidium satorium*
Celtis iguanaea	*Sabal causiarum*
Cirtocarpa velutinifolia	*Sideroxylon obovatum*
Cordia dentata	*Spondias mombin*
Crateva tapia	*Stenostomum acutatum*
Crossopetalum rhacoma	*Ximenia americana*
Eugenia procera	*Zanthoxylum flavum*
Geoffroea spinosa	*Zanthoxylum monophyllum*

4. Glossary

Dormancy	–	The inability of seeds to germinate directly upon imbibition.
Endocarp	–	Internal layer of the fruit coat or pericarp.
Endosperm	–	The tissue which serves the seedling with nutrition during germination and early seedling development. It may surround the embryo or already inside the cotyledons.
Fruit coat	–	See pericarp.
Hardseededness	–	The inability of seeds to absorb water.
Mesocarp	–	Middle layer of the fruit coat or pericarp.
Pericarp	–	Fruit coat. It consists of an outer layer, the exocarp, usually smooth or with hairs, a middle layer or mesocarp, which may be fibery, pulpy or juicy; and an inner layer or endocarp. This latter one often is woody. The different layers are often united or it is not clear what layer is what.
Seed coat	–	Testa. This is the layer of the seed that is in direct contact with the embryo and endosperm. It is usually quite thin (peanuts), but may be very hard as well (legumes).

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Appendix I.

Seed collection, storage behaviour, germination methods and survival characteristics of selected Bonarian tree species

Genus / species	Source	Storage behaviour	Germination method	Remark
Acacia tortuosa	Arnoldo 1967		Germination in 6 days	
Amyris simplicifolia	SID	n	n	
Bourreria succulenta	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Boursucc	n	Can be grown from de-pulped and scarified seed. Germination may take 1-2 months	Arnoldo 1967: 0% germination!
Bursera	SID		40% germination; pre-sowing treatments = seed sterilised (immersed in 10% Domestos solution for 5 mins); germination medium = 1% agar; germination conditions = 33/19°C, 12/12.	Data for *B. submoliniformis*
Bursera simaruba	SID; Ray & Brown 1995; JK Francis 1990	Orthodox?; Seeds survived drying to ambient relative humidity	Good survival without medium shade; enhanced survival in medium shade. Forty percent germination of viable seeds can be expected within 20 days. No pre-treatment is reported to be necessary. However, two attempts in Puerto Rico to germinate the seeds failed. This failure was probably caused by low germination rates in general and the need to scarify the hard testa. The sparseness of seedlings under the trees and in openings nearby seems to indicate low germination rates of naturally disbursed seeds, at least in Puerto Rico. Small wildlings (about 10 cm tall) survived transplanting into containers and developed to outplanting size (0.4 m tall) in 6 to 8 months. Exposure to full or nearly full sunlight appears to be a requisite for best growth. Planting containerized nursery stock and cuttings or transplanting wildlings are all viable methods for establishing ornamentals and timber plantations. No data are available to compare planting methods. Propagation by cuttings is easy. Branches up to 10 cm in diam. will root when one end is buried in the ground. Coppicing is vigorous when saplings to small sawlog-sized trees are cut, and windthrown trees are reported to sprout and regenerate themselves.	*Bursera simaruba* trees begin fruit production when 5 years old, and even earlier when grown from cuttings. Large trees can produce up to 60,000 seeds in one crop, but the average is close to 600 seeds per tree. On the other hand, small, open-grown trees, although not necessarily young trees, produce sparse crops of seeds. The seeds mature during the middle or end of the dry season and are dispersed by many bird and mammal species. Some strip off the fruit and drop the seeds while others swallow the fruits whole and later expel the seeds unharmed. One hundred air-dry seeds collected in Puerto Rico averaged 0.077 g per seed or 13,000 seeds per kg. Flowering usually coincides with the flushing of new leaves at the end of the dry season but varies by locality. After pollination, the fruits expand to full size in less than a week; however, the embryo remains minute for 8 months and then fills out just before fruit ripening. The fruits, 8 to 9 mm in diameter and 10 to 15 mm in length, are triangular or diamond shaped in cross section. The single seed is surrounded by a bony shell within a resinous, fleshy pericarp.

Genus / species	Source	Storage behaviour	Germination method	Remark
Bursera simaruba	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Burssima	Probably orthodox	Can be grown from seeds or cuttings, even large limbs. Seeds germinate within a month. Some say that plants grown from cuttings are not as strong as those raised from seed. Highly drought tolerant; does not require any supplemental water once established.	
Bursera simaruba	Navarrete-Tindall & Orellana Nunez 2002		Bursera simaruba is propagated by seeds or cuttings. Seed germination is fast, and percentage germination is between 80 and 100. Seeds do not require scarification treatments. Cuttings 1.5 to 3 m long and 5 to 20 cm in diameter are planted in a permanent location during the rainy season and root easily without growth regulators. Trees reach maturity in approximately 15 years when propagated from seed.	
Caesalpinia coriaria	Arnoldo 1967		Germination in 5 days	
Capparis See also under Cynophalla and Quadarella	SID	Orthodox; 89% viability following drying to mc's in equilibrium with 15% RH and freezing for 3 months at -20ºC.	89% germination; ; germination medium = 1% agar; germination conditions = 20°C, 8/16.	Storage and germination data for one of 5 cited spp: *Capparis chrysomeia* Bojer, *C. decidua* (Forssk.) Edgew., *C. hereroensis* Schinz, *C. mitchellii* Lindl., *C. spinosa* L. var. *canescens* Coss
Capparis	Ray & Brown 1995		Weak survival without medium shade; greatly increased survival in medium shade.	Data from *C. cynophallophora*
Capparis	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Cappcyno		Grown from seed, which need to be scarified. Start in shade and move to full sun after true leaves are formed. Germination is within a month. Highly drought tolerant; does not require any supplemental water once established.	Data from *C. cynophallophora*
Casearia tremula	Arnoldo 1967		'extraordinarily good germination' in 27-36 days	
Celtis	SID	Orthodox p; Viability can be maintained for several years in hermetic air-dry storage at 3°C.	1. 90% germination; ; germination medium = 1% agar; germination conditions = 25°C, 8/16. 2. 100% germination; ; germination medium = 1% agar; germination conditions = 35/20°C, 8/16.	Data for *Celtis africana*

Genus / species	Source	Storage behaviour	Germination method	Remark
Celtis	SID	4% germination (from initial germination of 20- 25%) following 5 years hermetic storage at ambient temperature; 60% germination following 9 years air-dry storage at 4°C with 40% r.h.	80% germination; pre-sowing treatments = imbibed on 1% agar for 8 weeks at 5°C, then seed scarified (covering structure partially removed); germination medium = 1% agar; germination conditions = 25/10°C, 8/16.	Data for *Celtis australis*
Celtis	SID	No loss in viability following 5.5 years hermetic air-dry storage at 10°C; dry seeds (mc not reported) survive overnight in liquid nitrogen.	78% germination; pre-sowing treatments = imbibed on 1% agar for 8 weeks at 5°C; germination medium = 1% agar; germination conditions = 25/10°C, 8/16.	Data for *Celtis occidentalis* L. = *C. crassifolia* Lam.
Cirtocarpa	SID	n	n	
Clusia	Arnoldo 1967		0% germination	
Coccoloba uvifera	Arnoldo 1967		77% germination; 'extraordinarily good germination' in 20-30 days.	
Coccoloba swartzii	Arnoldo 1967		0% germination	
Condalia henriquezii	Arnoldo 1967		0% germination	
Conocarpus erectus	Debrot, pers. obs.		Excellent germination from dry seeds	
Cordia			Propagated readily from seed, it grows very rapidly and requires nearly full sunlight.	Data for *C. alliodora* (Ruiz & Pav.) Oken
Cordia	SID	Orthodox; 100% viability following drying to mc's in equilibrium with 15% RH and freezing for 68 days at -20C.	1. 100% germination; presowing treatments = seed scarified (covering structure partially removed); germination medium = 1% agar; germination conditions = 25°C, 8/16. 2. 100% germination; presowing treatments = seed scarified (covering structure partially removed); germination medium = 1% agar; germination conditions = 35/20°C, 8/16.	Data for *C. curassavica* (Jacq.) Roem. et Schult.

Genus / species	Source	Storage behaviour	Germination method	Remark
Cordia	SID	Orthodox; 79% viability following drying to mc's in equilibrium with 15% RH and freezing for 293 days at -20C.	79% germination; pre-sowing treatments = remoisturised in high humidity over water for 5 days at 20°C, then seed scarified (covering structure removed, radicle and cotyledon end chipped to expose embryo); germination medium = 1% agar + 250 mg/l gibberellic acid (GA3); germination conditions = 20°C, 8/16.	Data for *C. caffra* Sond.
Cordia	SID	90% viability following drying to mc's in equilibrium with 15% RH and freezing for 1 month at -20°C.	1. 75% germination; pre-sowing treatments = seed scarified (chipped with scalpel); germination medium = Sand; germination conditions = 25°C, 8/16. 2. 90% germination; pre-sowing treatments = imbibed on 1% agar for 4 weeks at 15°C, then seed scarified (chipped with scalpel); germination medium = 1% agar; germination conditions = 15°C, 8/16. 3. 90% germination; pre-sowing treatments = imbibed on 1% agar for 4 weeks at 25°C, then seed scarified (chipped with scalpel); germination medium = 1% agar; germination conditions = 25°C, 8/16.	Data for *C. monoica* Roxb.
Cordia	Allen 2002		Seeds of other *Cordia* species can retain some viability for up to 1 year when stored in airtight containers, but sowing fresh seed is recommended. Because the seeds are very difficult to extract without damage, whole capsules are generally sowed. No pre-treatment is required, but germination may be accelerated by clipping off a portion of the hard, dry capsule. Capsules are sowed at a depth of approximately 1.5 to 2 cm. Germination begins in about 3 to 4 weeks; most seeds will germinate within 6 weeks, but some may take as long as 3 to 4 months. If more than one seedling germinates from a capsule, thinning may be necessary. When the capsule sufficiently decays, the seedlings should be carefully separated and potted individually. Seedling growth during the first season is slow, with seedlings	Data for *C. subcordata*, close to *C. sebestena*: The fruit is drupaceous, almost round, green when young, and brown and hard at maturity. The fruits (capsules) are approximately 2.5 cm long, and contain up to four white seeds, each about 10 to 13 mm long. The fruits can be collected from the ground or picked directly from the trees by hand or with a pruning pole. Specific recommendations for storing *C. subcordata* seed are unavailable.

Genus / species	Source	Storage behaviour	Germination method	Remark
			typically obtaining a height of about 10 to 15 cm. Seedlings can be outplanted at this height, or retained in the nursery for a second season after which they may reach 1.5 m in height. Larger seedlings can be top-pruned or trimmed of lower branches before outplanting. Outplanted seedlings perform well in moderate shade. Seedlings may require supplemental watering on drought-prone sites, especially when planted in full sunlight.	
Cordia dentata (C. alba)	Arnoldo 1967		'extraordinarily good germination' in 22-26 days.	
Crateva		Orthodox; 90% viability following drying to mc's in equilibrium with 15% RH and freezing for 3 months at -20ºC.	1. 90% germination; ; germination medium = 1% agar; germination conditions = 25°C, 8/16. 2. 90% germination; ; germination medium = 1% agar; germination conditions = 30°C, 8/16.	Data for C. greveana Baill.
Crateva tapia	Debrot, pers. obs.		Good germination within 2 weeks after planting	Seeds often quickly destroyed by insects while fruit is ripening on the tree.
Crescentia cujete	Arnoldo 1967		'Extraordinarily good germination' in 9 days	
Crossopetalum rhacoma	SID	n	n	
Cynophalla flexuosa	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Cappflex		Can be grown from seed in a community pot in light shade to full sun. Transplant after first true leaves form. Highly drought tolerant; does not require any supplemental water once established.	
Cynophalla hastata	Debrot, pers. observ.		Excellent germination when planted immediately after riping.	
Cyrtocarpa velutinifolia	Debrot, pers. obs.		Very poor germination from freshly planted seeds	
Eugenia procera	SID	n	n	
Ficus britonii	Wakkee 1986			

Genus / species	Source	Storage behaviour	Germination method	Remark
Geoffroea spinosa	SID	Orthodox p	1. 83% germination; pre-sowing treatments = imbibed on 1% agar for 2 weeks at 20°C, then seed scarified (covering structure removed); germination medium = Sand; germination conditions = 20°C, 8/16. 2. 82% germination; pre-sowing treatments = imbibed on 1% agar for 2 weeks at 25°C, then seed scarified (covering structure removed); germination medium = Sand; germination conditions = 25°C, 8/16.	Data for *G. decorticans* (Gillies ex Hook. & Arn.) Burkart
Guaiacum	Francis 2002	Intermediate	Usually, the seeds must be removed from the fruits. They can be removed by hand, or the fruits can be dried in the shade, soaked to soften them, and then wet-sieved to remove the pulp. The seeds are dried and stored at 5 to 8 °C. However, stored seeds begin to lose their viability after 1 month. An alternative strategy is to germinate the seeds at once and maintain the slow-growing seedlings in the nursery until needed. Air-dried seeds of G. officinale collected in Puerto Rico averaged 3,550 seeds per kg (Francis and Rodríguez 1993). Germination is epigeous and begins within 10 to 12 days after sowing. In Cuba, up to 60 percent of fresh seeds germinate. A test using Puerto Rican seeds resulted in 9-percent germination of fresh seeds, 5-percent with seeds stored for 1 month at 5 °C, 20-percent with seeds stored for 1 month at 26 °C, and 10-percent with seeds stored for 2 months at 26 °C. Another test of Puerto Rican seeds obtained only 7-percent germination in the first month, with an additional 41 percent germinating over the next 9 months. In a test of several seed pretreatments, cycles of daily soaking and drying for 1 week gave the only improvement in germination over untreated seeds. The seeds are usually germinated in trays or beds and transplanted when 2 to 4 cm in height. Seedlings for forest or	Data for *G. officinale* Flowering lasts for about 1 month and may occur from early spring to fall in Puerto Rico and from March through May in Cuba. Not all trees in a stand flower at the same time. Trees in one forest planting began flowering and fruiting about 25 years after planting (Francis 1993). The 2-cm-wide blue flowers grow in clusters at the twig terminals. The orange to orange-brown fruits are flattened, two-chambered capsules. At maturity, they split open to expose two seeds that are covered with a red, fleshy aril . Fruit and seed production is usually abundant. Fruits in one collection in Puerto Rico weighed an average of 0.39 ± 0.11 g each (Francis and Rodríguez 1993). Fruits that are beginning to split can be picked up from the ground, picked by hand from low trees, or clipped with pruning poles.

Genus / species	Source	Storage behaviour	Germination method	Remark
			ornamental plantings are grown in pots or nursery bags. The potting mix should drain well and contain some lime. Seedlings grow to 20 to 30 cm in 18 to 24 months, when they can be outplanted. Long-term weeding will promote successful forestry plantings. Because grazing and browsing animals carefully avoid the seedlings and saplings, planting in overgrazed areas could be a wise establishment strategy. Fire must be completely excluded.	
Guaiacum	SID	Orthodox; 89% viability following drying to mc's in equilibrium with 15% RH and freezing for 34 days at -20C.	89% germination; germination medium = 1% agar; germination conditions = 20°C, 8/16.	Data for *G. inijugum* Brandegee
Guaiacum	Francis & Rodriguez 1993; Ray & brown 1995		Germination 48%; method M (potting mix, no scarification); first germination after 17 days. Weak survival without medium shade; greatly increased survival in medium shade.	Data for *G. officinale* L.
Guaiacum officinale	Arnoldo 1967	Germination after 1 month storage: 20% at 26 °C, 5% at 5°C	Germination 9% in20 days. Soak seeds for an extended period in water	
Guaiacum sanctum	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Guaisanc	Recalcitrant; Plant right away; seeds do not store well.	Can be grown from seeds cleaned of pulp. Place in light shade or full sun. Highly drought tolerant; does not require any supplemental water once established.	
Guaiacum sanctum	Marin & Flores 2002	Recalcitrant: Seeds can be stored for 1 month at 5 to 8 °C. They lose viability in less than 1 month if stored at ambient temperature and humidity.	Fresh seeds have 40 to 60 percent germination in nurseries. Seeds can be immersed in running water (at 20 °C) for 24 hours before sowing. Germination is epigeal, and the seedling is phanerocotylar. Germination begins 6 to 8 days after sowing and ends in 16 to 20 days. Seeds are planted at a depth of 1 cm in germination boxes filled with sand; when they are 6 cm tall, they are transferred to nursery bags. Seedlings are ready for outplanting 1 year after	The fruit is a two to five-lobed or ridged obovoid capsule 14 to 16 mm long and 12 to 18 mm wide. The fruit is fleshy or moist at maturity but dries to a yellowish and lustrous hard surface. The seeds are ellipsoid, about 1 mm long, and brown to black with a red aril. Fruits must be collected from the soil very early in the morning to avoid seed predation by rodents. The fruits are placed on the floor and dried for 7 days in the shade; later the fruit pericarp is removed

Genus / species	Source	Storage behaviour	Germination method	Remark
			sowing, when they reach 30 to 40 cm in height. Like *Guaiacum officinale*, the primary problem at the nursery is leaf-eating insects: *Kricogonia castalia* (Fabr.), *Iridopsis* sp. and *Gnorimoschema* sp.. Regeneration is very good within the forest, with hundreds of seedlings and saplings; however, very few of them manage to survive to maturity.	with running water to extract the seeds. The seeds are then dried in the shade and stored in hermetic containers. Seeds average 20,000 per kg.
Guapira fragrans	Ray and Brown 1995. Arnoldo 1967.	n	Good survival without medium shade; enhanced survival in medium shade. 0% germination	
Guapira	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Guapdisc		Can be grown from de-pulped seeds. Place in light shade or full sun. Germination is usually in 2-3 weeks.	Data for *G. discolor*
Haematoxylon brasiletto	Debrot, pers obs.		Excellent germination within 1 week	
Hippomane mancinella	Arnoldo 1967		Germination in 21 days.	
Jacquinea arborea	Francis & Rodriguez 1993 Arnoldo 1967	n	100% germination after 8 days, germinated on filter paper (blotter paper method). 'extraordinarily good germination'	
Krugiodendron ferreum	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Krugferr	Recalcitrant	Can be grown from seed. Plant right away; seeds do not store well. Place container in light shade.	
Maclura tinctoria (Chlorophora tinctoria)	Arnoldo 1967		Germination in 11 days.	
Malpighia emarginata (M. punicifolia)	Arnoldo 1967	n	'extraordinarily good germination' in 17-24 days.	
Malpighia glabra	Arnoldo 1967		Germination in 12 days.	

Genus / species	Source	Storage behaviour	Germination method	Remark
Manihot carthaginensis	SID	Orthodox; 80% viability following drying to mc's in equilibrium with 15% RH and freezing for 71 days at -20C.	80% germination; ; germination medium = 1% agar; germination conditions = 30°C, 8/16.	Data for *Manihot carthaginensis* (Jacq.) Müll.Arg. subsp. *glaziovii* (Müll.Arg.) Allem
Manihot	Guevara & Ospina 2002	Orthodox	In a 14-month study, it was suggested that the behaviour of the sexual seed of *Manihot* is similar to the conventional type of orthodox seeds. With a moisture content between 4 and 6 percent (wet basis), the seed was stored in sealed packaging under cold conditions (5 °C) without losing viability. On the other hand, others report that the *M. esculenta* seeds did not lose viability after 14 years in hermetic packaging at –20 °C with 6.1 percent moisture content. In this genus, the seeds differ in degrees of dormancy and many different treatments have been tested to improve germination. *Manihot grahamii* is propagated by seed. There is no information on how seeds are planted, type of substrate, or special care for the seedlings. Treatments with sulphuric acid at 2, 5, and 10 percent resulted in a negative effect on seeds of *M. esculenta*. Evaluation of constant and alternate ranges of temperature revealed that during 21 days, 30 to 38 °C for 8 to 16 hours is the most recommended condition for germination.	Data for *M. grahamii* Hook. and *M. esculenta* L. Like other *Manihot* species, seeds can be collected on the ground around the tree. To prevent fruit fly damage and seed dispersal, seeds may be collected by placing mesh bags around the peduncle of an inflorescence.
Maytenus	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Maytphyl	n	Moderately drought tolerant; generally requires moist soils, but tolerant of short periods of drought once established.	Data for *M. phyllanthoides*
Maytenus versluysii	Debrot, pers. obs.		High germination frequency within 2 weeks from seeds ripened from tree and planted quickly	

Genus / species	Source	Storage behaviour	Germination method	Remark
Melicoccus bijugatus (Melicocca bijuga)	Arnoldo 1967 Francis 1992a		Germination in 11 days. In a test in Puerto Rico, first germination of untreated seeds occurred 28 days after sowing and continued for 2 months; 63 percent of the seeds germinated. Germination is hypogeous. The newly emerging shoot elongates about 10 cm before spreading the first leaves. Seedlings develop slowly. A group of seedlings grown in pots in Puerto Rico averaged just 39 cm in height 18 months after sowing. The species is apparently difficult to transplant, which probably means that bare-root stock and wildlings are prone to high mortality. Potted seedlings are transplanted successfully into moist ground.	Seedlings are plentiful below trees in St Martin (authors' obs.) The small, fragrant, greenish-white flowers are borne in clusters (panicled) at the ends of branches. Flowers are mostly of one sex on individual trees (dioecious) but also can be bisexual (monoecious). The fruits (drupes), which grow in clusters, have a green or greenish-yellow, leathery exocarp (outside). They contain one or occasionally two large seeds, each covered by fibres, and a salmon-coloured, gelatinous layer (the edible portion). A sample of 60 air-dried, cleaned seeds from Puerto Rico averaged 2.64 g per seed or 379 seeds per kg. The fruiting of quenepa is apparently more regular in dry zones along streams or in moist coves than on exposed hillsides or in higher rainfall zones. Fruit and seed production begins in 7 to 10 years from seed and in 4 to 5 years in vegetatively propagated stock. Most seeds fall under the parent tree. Distribution of naturalized trees (along roads, trails, and near old farmsteads), suggests that humans are the major long-distance dispersers in Puerto Rico. Dispersal by birds and bats is suggested for Trinidad and Tobago. Weeding for 2 or 3 years will be required to get the seedlings above grass and brush competition. Direct seeding could work, provided the seed spots are weeded frequently for a least 2 years. Young trees coppice when cut. Selected strains of quenepa can be propagated by layering and grafting onto ordinary rootstalks. Successful rooting of cuttings has not been documented.
Metopium	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Metotoxi	Probably orthodox.	Can be grown from seed. Highly rought tolerant; does not require any supplemental water once established.	Data for *M. toxiferum*
Peltophorum acutifolium (P. suringarii)	Arnoldo 1967		Germination in 6 days.	

Genus / species	Source	Storage behaviour	Germination method	Remark
Phyllanthus botryanthus	Arnoldo 1967		Germination in 11 days.	
Prosopis juliflora	Arnoldo 1967	Germination after 2 months of storage: 61% at 5°C, 20% at 26°C	64% germination in 11 days.	Deep taproot with a strongly dispersing shallow lateral roots
Psidium	SID	Orthodox; MCS= 21% Seeds at 6% mc survive 24 hours in liquid nitrogen; no loss in viability following 66 months hermetic storage at -20°C with 5.5% mc (SSLR); long-term storage at IITA Genebank.	100% germination; ; germination medium = 1% agar; germination conditions = 21°C, 12/12.	Data for *P. guajava* L.
Psidium	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Psidlong	n	Can be grown from de-pulped seed. Moderately to highly drought tolerant; plants growing in extremely dry soils may die during extended periods of drought	Data for *P. longipes*
Quadarella indica	Debrot, pers.obs.		Good germination within 2 weeks from planting fresh seeds	Seeds very vulnerable to insects while fruits are ripening on tree.
Ruprechtia curranii (R. coriacea)	Arnoldo 1967		'extraordinarily good germination' in 11 days.	
Sabal	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Sabaeton	n	Highly drought tolerant; does not require any supplemental water once established.	Data for *S. etonia*
Sabal	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Sabapalm	n	Can be grown from seed from which the coating has been removed. Scatter seed over surface of soil and barely cover. Place container in light shade to full sun. Germination is in about 6 weeks. Growth is usually very slow.	Data for *S. palmetto*
Sabal causiarum	Francis & Rodriguez	n	94% germination after 21 days. Germination in sand.	

Genus / species	Source	Storage behaviour	Germination method	Remark
	1993			
Senna atomaria (Cassia emarginata)	Arnoldo 1967		'extraordinarily good germination' in 4 days.	
Sideroxylon	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Sidecela	n	Can be grown from seed. Moderately drought tolerant; generally requires moist soils, but tolerant of short periods of drought once established. Arnoldo 1967: 0% germination	Data for *S. celastrinum*
Sideroxylon	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Sidetena	n	Can be grown from de-pulped seed. Highly drought tolerant; does not require any supplemental water once established	Data for *S. tenax*, *S. foetidissimum, S. salicifolium*
Sphinga platyloba (Pithecellobium platylobum)	Arnoldo 1967		Germination in 6-38 days.	
Spondias mombin		n	22% germination after 12 days. Germination in potting mix.	
Spondis mombin	Francis 1992b		Germination is hypogeal. Seeds sown in Puerto Rico began germinating within 12 days of sowing. A 90-per– cent germination was obtained within 20 days of sowing seeds in Mexico. Some of the seeds produce two or more plants each. When this occurs, it is necessary to thin by pinching off all but one shoot. Seedlings in Puerto Rico that had been grown in nursery bags were ready to outplant at 3.5 months from sowing when they averaged 48 cm in height. The tree is frequently propagated by placing branch cuttings in moist ground. Cuttings 50 to 100 cm long and 5 to 10 cm in diameter are usually stuck vertically with half their length exposed. In fact, living fences are established by setting freshly cut fence posts into moist ground. Young trees coppice well, and large trees will sometimes sprout after cutting.	In the Antilles, the species flowers mainly from winter to summer, and fruit matures from summer to winter. The fruit is a yellow, fleshy drupe about 2 to 2.5 cm thick and 3 to 4 cm long containing a multiseeded stone about 2.5 cm long. A sample of seeds from Puerto Rico averaged 0.85 ± 0.04 g per seed (850 seeds per kilogram) (author, personal observation). Another sample from Mexico averaged 0.68 g per seed (680 seeds per kilogram). Large trees may produce more than 100 kg of fruit per year. Fruit and seed production usually begins when the tree is around 5 years old. Howler monkeys, *Aluoatta palliata*, feed on hogplums in Mexico, and they disperse the seeds over a 3-month period each year. Bats and birds, as well as deer, which swallow but do not digest the seeds, are also reported to be dispersal agents.

Genus / species	Source	Storage behaviour	Germination method	Remark
Stenostomum	SID	Orthodox; 75% viability following drying to mc's in equilibrium with 15% RH and freezing for 43 days at -20C.	75% germination; pre-sowing treatments = seed scarified (covering structure partially removed); germination medium = 1% agar; germination conditions = 25°C, 8/16.	syn.: *Antirhea*; Data for *S. myrtifolium* Griseb.
Tabebuia billbergii	Debrot, pers. obs.		Excellent germination within 2 weeks from ripe seeds collected from the tree	
Trichilia trifolia	Arnoldo 1967		0% germination	
Thespesia populnea	Debrot, pers. observ		Excellent germination within 2 week after planting	
Ximenia americana	SID	Orthodox; 88% viability following drying to mc's in equilibrium with 15% RH and freezing for 1 month at -20°C.	1. 80% germination; pre-sowing treatments = seed sterilised (immersed in 10% Domestos solution for 5 mins); germination medium = 1% agar + 250 mg/l gibberellic acid (GA3); germination conditions = 25°C, 8/16. 2. 88% germination; pre-sowing treatments = seed sterilised (immersed in 10% Domestos solution for 5 mins); germination medium = 1% agar; germination conditions = 26°C, 12/12.	
Ximenia americana	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Ximeamer	n	Can be grown from de-pulped seed. It is semi-parasitic on the roots of other hardwoods, which makes it somewhat challenging to grow; some will place a *Quercus virginiana* oak in the same container as a host. Moderately drought tolerant; generally requires moist soils, but tolerant of short periods of drought once established.	
Ximenia americana	Sacandé & Vautier 2006		The seed is orthodox and should be stored at low moisture content and as cold as possible. It tolerates drying to 3.2% mc and temperatures as low as -20°C. For short term storage, the seed can be stored moist. It is essential for the successful moist storage of orthodox seeds that the seeds are ventilated frequently. After 17 days of moist storage in vermiculite at 26°C, germination was 100% (initial germination before storage was 93.4%).	The flowers are unisexual and male and female flowers occur on different plants. Flowering and fruiting varies between localities, but flowering typically occurs in the dry season. In many places it flowers and fruits throughout the year. On good sites trees may produce fruit after 3 years of growth. The fruits are dispersed by animals. Yellow-red, mature fruits are collected by either hand picking, or shaking the branches to release the fruit. Fruits are after-ripened for

Genus / species	Source	Storage behaviour	Germination method	Remark
			Removal of the seed coat prior to germination or sterilisation of the seeds (e.g. by immersion in sodium hypochlorite for 5 minutes) can increase germination. Germination is hypogeal. Seeds readily germinate between 26 and 36°C, with the germination rate being fastest at 31°C. Under such conditions the seeds germinate c. 90% in 8-30 days, in the laboratory or sown in sand in the nursery. When the seed coats are intact the seeds germinate in about 16 days, removing the seed coat reduces the germination time to about 10 days. It is not recommended, however, to remove the seed coat before sowing as it may damage the seed and reduce germination.	2-3 days after collection, until the fruits have reached full maturity. The fruits are kept at air temperature, high moisture levels and are ventilated. Care must be taken when after-ripening the fruit, since germination of the seeds can be reduced if the fruits are allowed to ferment. Therefore, the fruits should be processed as soon as they are ripe. The seeds are extracted by rubbing the fruit on a wire mesh to remove the pulp, and then washing the seeds in running water to remove the mucilage. The seeds can then be cleaned by hand sorting, and dried in either the sun or the shade.
Zanthoxylum flavum	Francis 1997 Arnoldo 1967*		Two Puerto Rican seed lots that had been heavily attacked by insects averaged 36,000 and 44,000 seeds per kg. Five percent of the seeds in the first lot germinated, beginning 30 days after sowing. Air-dried seeds from 2 other seed lots averaged 66,000 and 47,000 seeds per kg. In the first lot, 79 percent of the seeds had been damaged by insects. The second was collected from trees that had been sprayed with insecticide and was free of damage; however, both lots failed to germinate. Another seed lot collected a few days later from the same sprayed trees germinated at 60 to 70 percent in one nursery and 12 to 20 percent in another; the period from sowing to start of germination was 48 days. 5% germination* in 30 days.	*Z. flavum* produces flowers mainly from winter to summer and fruits from spring to fall (5). The flowers and fruits are borne on many-branched clusters (panicles) 5 to 12 cm long. The tree is dioecious, bearing male and female flowers on different trees. The fruits are small pods about 6 mm in diameter that split in half when mature to release one shiny, black seed about 3 mm in diam. An open-grown tree produces fairly large numbers of seeds (estimated at 10,000 to 100,000) per flowering cycle. The dispersion vectors are assumed to be seed-eating birds and bats as with Z. martinicense (Lam.) DC. Whether for lack of viable seed, lack of suitable natural seedbeds, or competition from other vegetation, seedlings and saplings are very rare in the wild in Puerto Rico. Seedlings develop slowly, even under nursery conditions. It requires about 1 year to produce 30- to 50-cm seedlings in plastic nursery bags. A total of 277 seedlings, planted in the moist limestone hills of northern Puerto Rico, averaged 2.70 m in height at 5 years. Survival was estimated to range from 60 to 80 percent. Seedlings, saplings, and trees (at least to pole-size) will sprout when cut. There have been no reported attempts to root or graft cuttings.

Genus / species	Source	Storage behaviour	Germination method	Remark
Zanthoxylum	Francis & Rodriguez 1993	Probably orthodox	5% germination after 40 days. Germination in potting mix.	Data from *Z. martinicense* (Lam.) DC.
Zanthoxylum	http://regionalconservation.org/beta/nfyn/plantdetail.asp?tx=Zantcori	n	Can be grown from seed removed from the outer coating. Scatter seeds over soil and barely cover. Highly drought tolerant; does not require any supplemental water once established. Z. fagara: Germination is in about a month.	Data from *Z. coriaceum, Z. clava-herculis, Z. fagara*

n= no data available.

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Appendix II.
Growth measurements per species

Name	Length in cm after 100 days	Length in cm after 230 days
Acacia tortuosa (Wabi)	110	150
Bourerria succulenta (Watakeli)	340	350
Caesalpinia coriaria (Dividivi)	110	145
Cassia emarginata (Bonchi largu)	120	125
Chlorophora tinctoria (Palu dushi)	33	130
Coccoloba uvifera (Dreifi di laman)	45	110
Cordia alba (Karawara)	200	250
Crescentia cujete (Kalbas)	120	140
Haematoxylon brasiletto (Brasia)	45	120
Jacquinia armillaris (Mata Piská)	45	55
Parkinsonia aculeata (Bonchi di strena)	220	290
Peltophorum suringari (Curahout)	110	160
Pithecellobium platylobum (Dabaruida)	230	320
Pithecellobium ungis-cati (Uña-gatu)	?	140

Source: Arnoldo 1967.

Appendix III.

Description of trees with their soil preferences

(source: Wakkee P.F., J.A. De Freitas & O.D. Van de Veer, 1986.
Vegetatieschema ten behoeve van stedelijke inrichting en landscaping op de Benedenwindse Eilanden. 25 pp., 3 bijlagen. Carmabi/DROV Rapport.)

ZONE 1 VEGETATIE : DE PLANTEN VAN DE KUST (ZOUTRESISTENT)

A HOOGOPGAANDE TOT RONDE BOMEN											BESCHRIJVING			
NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN-DRAGEND	BLAD HOUD.	GROEI	KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
A1 Grote boom ( )10 m)														
Casuarina equisitifolia (Casuarina)	X	-	-	-	X	-	-	X	XX	Smal, ijl. Afhangende twijgen.	tot 12m	30-40cm	Uitgebreid, oppervlakkig.	Gekweekt. Matig arme, zandige grond.
Melia azedarach (Alei)	X	-	X	-	-	X	-	-	X	Halfrond of vlak. Dicht gebladerte	tot 13m	tot 20cm	?	Gekweekt
A2 Tamelijk grote boom (5-10m)														
Thespesia populnea (Otaneita)	X/-	-	-	-	X	X	-	X		Dicht gebladerte. Breed uitstaande takken.	5-10m	tot 20cm	?	Voorkeur voor brakke grond. Grote tuinen.
A3 Kleine boom (tot 5m)														
Jacquinia barbasco (Mata di pisca)	XX	XX	-	-	X	-	-	X	--	Bolvormig, compact. Sterk vertakt	tot 4m	15-20cm	?	Kalkrotsen en kalkhoudende grond en diabaas
B BREEDGROEIENDE TOT TRAPEZIUMVORMIGE BOMEN														
B2 Tamelijk grote boom (5-10 m)														
Coccoloba swartzii (Camalia)	XX	XX	X	-	X	-	-	X		Compact, smal of rond	4.5-10m	tot 20cm	?	Kalkhoudende gronden of diabaas.
Coccoloba uvifera (Dreifi di laman)	X	XX	-	X	-	-	-	X	X	Sterk afhankelijk van standplaats. Boom of heester.	4.5-10m	40-50cm	?	Vruchtbare, lichte zandgrond. Stranden.
Conocarpus erecta (Mangel)	X	-	X	-	(X)	-	-	X		Breeduitstaand.	6-10m	tot 30cm	?	Vruchtbare grond. Kusten, zilte gronden
Laguncularia racemosa (Mangel blancu)	X	-	X	-	-	-	-	X	X	Vol. Parapluvormig.	tot 6m	tot 30cm	Mangrove met pneumatoden.	Kusten, zilte gronden
Rhizophora mangle (Mangel tan)	X	-	-	-	-	-	-	X		Vol.	tot 10m	tot 15cm	bovengronds: stelt- en luchtwortels. ondergronds: zowel diepgaand als oppervlakkig.	Modderige kusten, zilte gronden
B3 Kleine boom (tot 5m)														
Avicennia germinans (Mangel blancu)	X	-	X	-	-	-	-	X		Rond, breeduitstaande takken. Vol.	tot 4,5m	tot 30cm	Lange, horizontale wortels met opgerichte pneumatophoren	Modderige kusten.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN- DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
Caesalpina coriaria (Watapana, Divi-divi)	XX	XX	X	-	-	-	-	X		Breeduitstaand, tot 10m in diameter	tot 5m	tot 30cm	?	Alle grondsoorten
C PALMBOMEN														
C1 Grote boom ( )10 m)														
Cocos nucifera (Coco)	X	-	-	X	-	-	-	X		Dicht op elkaar staande, overhangende bladeren	5-20m	Slank	Recht naar beneden tot 5m, opp. lange zijwortels	Alle grondsoorten (gekweekt).
C3 Kleine boom (tot 5m)														
Sabal palmetto (Cabana)	X	X	-	-	X	-	-	X	--	Palm, zeer stijve bladeren.	tot 5m	tot 25cm	Lang, recht naar beneden	Knipheuvels. Voor landscaping en tuin
ZONE 2 VEGETATIE : DE PLANTEN VAN DE OVERGANGSZONE (ZOUTVERDRAGEND)														
A HOOGOPGAANDE TOT RONDE BOMEN														
A1 Grote boom ( )10 m)														
Achras zapota (Mispu)	-	-	X	X	-	-	-	X		Groot, dicht, rond.	tot 15m	tot 30cm	?	Gekweekt
Hippomane mancinella (Manzaliffa)	X	X	X	-	-	-	-	X		Sterk vertakt.	tot 13m	tot 60cm	?	Voorn. in vlakten in de nabijheid van de zee.
Swietenia mahagoni (Mahok)	X/-	-	X	-	-	-	-	X		Groot, rond. Sterk vertakt.	6-15m	90-135cm	?	Gekweekt, hofjes. Voorkeur voor diepe, vruchtbare grond.
A2 Tamelijk grote boom (5-10 m)														
Leucaena leucophala (Tumba rabu)	X	X	-	-	-	X	-	X	X	Smalle, ijle boom of ronde, veelvertakte heester.	3-6m	5-10cm	Zeer diepgaand, agressief.	Best op humusrijke, goeddoorlatende grond. Stijle hellingen.
Hibiscus elatus (Mahoe)	-	-	-	-	X	X	-	X		Groot, rond.	tot 12m	tot 30cm	?	Gekweekt
Sapindus saponaria (Savonetapel)	-	-	X	-	X	-	-	X		Compact. Rechte takken.	tot 7m	tot 30cm	?	Gekweekt

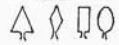
NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN- DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
A3 Kleine boom (tot 5m)														
Bontia daphnoides (Olijfi)	X	X	-	-	-	-	-	X		Vol.	tot 4m	tot 25cm	?	Alle gronden. Voorkeur voor iets brakke grond.
Euphorbia lactea (Cactus suriname)	XX	XX	-	-	X	-	X	X		Sterk vertakte succulent	tot 5m	20-30cm	?	Moeilijk te reboiseren plaatsen. (gekweekt)
Hibiscus tiliceus (Wanu)	-	-	X	-	X	-	-	X	XX	Dichtbebladerd, sterk vertakt. Bolvormig.	3-5m	tot 15cm	Zeer uitgebreid.	Gekweekt. Verdraagt zilte grond.
Metopium brownei (Manzaliffa bobo)	X	X	X	-	-	-	-	X		Vol, bolvormig.	3-5m	ca. 25cm	?	Kalkheuvels en plateaus tot vlak aan zee.
Moringa oleifera (Benboom)	-	-	-	-	-	X	-	X		IJl, breeduitstaande takken.	4-5m	tot 25cm	?	Gekweekt. Beschut, niet te droog.
B BREEDGROEIENDE TOT TRAPEZIUMVORMIGE BOMEN														
B1 Grote boom ( )10 m)														
Albizia lebbeck (Barba di jonkuman)	X/-	X/-	X	-	-	X	-	-	X	Vol, breed-bolvormig. Breedgetakt.	tot 15m	tot 50cm	Oppervlakkig, zeer uitgebreid. Vernielt plaveisel ed.	Verschillende gronden. Laagvlakte, wegen, tuin en plantsoenen. Gekweekt
Prosopis juliflora (Inju)	XX	XX	X	-	-	-	X	X	X	Plat, breed. Zeer lange, horizontale takken.	tot 15m	tot 45cm	Diepgaande penwortel en sterk verbreidende oppervlakkige zijwortels.	Goed op zandige en rotsachtige gronden.
Clusia sp. (Dam machu)	-	-	X	-	-	X	-	X		Vol, breed. Lange horizontale takken.	tot 15m	tot 60cm	?	Goede humusgrond.
Terminalia catappa (Wilde amandel)	X	X	X	X	-	-	-	-	X	Kransen van horizontale takken.	9-15m	tot 30cm	?	Zandige zeekust. Heeft veel ruimte nodig. Gekweekt
B2 Tamelijk grote boom (5-10 m)														
Bursera simaruba (Palu di sia cora)	X	XX	-	-	X	-	-	-		IJl, breed.	6-10m	30-60cm	?	Herbeplanting op alle gronden.
Euphorbia tirucalli (Potloodplant)	XX	X	-	-	X	-	-	X		Borstelige kroon van potloodvormige takken.	tot 10m	tot 30cm	?	Gekweekt.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN- DRAGEND	BLAD HOUD.	GROEI	KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
B3 Kleine boom (tot 5m)														
Capparis odoratissima (Oliba)	X	X	-	-	X	-	-	X		Dicht, compact.	tot 5m	tot 30cm	?	Op heuvels en in laagvlakte. Voorkeur voor kalkhoudende grond. Tot vlak aan zee.
Condalia henriquezii (Beshi di cabritu)	X	XX	-	-	-	-	X	X		Dunne, afhangende twijgen	tot 4m	tot 25cm	?	Zuidkust tot vlak aan zee.
Crescentia cujete (Calbas)	X	XX	-	-	X	-	-	-	X	Breed, ovaal, open. Onregelmatige vorm.	tot 4m	20-30cm	?	Op alle grondsoorten.
Delonix regia (Flamboyant)	X	X	-	-	-	X	-	-	X	Breed, plat. Soms breder dan hoog.	tot 5m	25-60cm	Oppervlakkig.	Gekweekt. Tuinen en plantsoenen.
Guaiacum officinale (Wayaca)	X	XX	X	-	X	X	-	X	--	Rond, koepelvormig.	tot 5m	30-40cm	?	Alle gronden.
Guaiacum sanctum (Wayaca shimaron)	X	XX	X	-	-	X	-	X		Breed-rond. Smalle hangende takken.	tot 4m	tot 20cm	?	Alle gronden.
Krugiodendron ferreum (Caubati)	X	X	X	-	-	-	-	X		Dichtbebladerde takken in horizontale lagen.	3-4,5m	20-40cm	?	Liefst kalkhoudende gronden.
Plumeria rubra (Oleander)	XX	XX	-	-	X	X	-	-	X	Koepelvormig. Blad aan buitenkant kroon.	tot 4m	tot 30cm	Oppervlakkig. Vergaand	Gekweekt. Alle gronden.
Rhacoma crossopetalum (Placa chikitu)	X	XX	-	-	-	-	-	X		Slanke, hangende takken.	3-5m	tot 25cm	?	Kalkplateaus, zandige stranden.
C PALMBOMEN														
C1 Grote boom ( )10 m)														
Phoenix dactylifera (Dadelpalm)	X	X	-	X	X	-	-	X		Palm. Vol, tot 4m lange bladeren.	10-30m	40-60cm	?	Gekweekt.
C2 Tamelijk grote boom (5-10 m)														
Copernicia tectorum (Palmiet)	X	-	-	-	X	-	-	X		Slanke palmsoort. Rond, klein, vol.	4-6m	tot 25cm	?	Hofjes en tuin. Gekweekt
C3 Kleine boom (tot 5m)														
Phoenix canariensis (Dader)	X	X	-	-	X	-	-	X		Palm met grote, volle kroon van zeer lange bladeren.	tot 5m	ca 1m	?	Gekweekt.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN- DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
D CACTACEEEN														
D2 Tamelijk grote boom (5-10 m)														
Cereus repandus (Brebe, Cadushi)	XX	XX	-	-	-	-	X	X	X	Zuilcactus met vele rechtopgaande takken.	tot 10m	tot 40cm	Breed en oppervlakkig.	Verschillende gronden. Droog.

ZONE 3 VEGETATIE : ZOUTMIJDENDE VEGETATIE

A HOOGOPGAANDE TOT RONDE BOMEN



A1 Grote boom ( )10 m)

Artocarpus incisa (Palu di frut'i pan)	-	-	-	X	-	-	-	X		Breedgetakt. Relatief weinig, dikke takken.	tot 13m	tot 60cm	Ongeordend met oppervlakkige massa van rel. fijne wortels.	Verscheidenheid bodems mits diep.
Erythrina velutina (Boonchi di cabai)	X	XX	-	-	-	X	X	-		Vol, sterk vertakt.	tot 15m	tot 100cm	?	Oostelijk deel van Curacao
Mangifera indica (Mango)	-	-	X	X	-	-	-	X		Vol, koepelvormig. Dikke, horizontale zijtakken.	10-15m	tot 90cm	Lange diepgaande hoofdwortel en dichte massa oppervlakkige bijwortels.	Gekweekt.
Melicocca bijuga (Kenepa)	X	XX	X	X	-	-	-	X		Vol, sterk vertakt.	9-12m	30-60cm	?	Gekweekt. Droge gronden.
Tamarindus indica (Tamarijn)	XX	XX	X	X	-	-	-	X	-	Rond, vol. Sterk vertakt.	tot 13m	tot 90cm	?	Best in vruchtbare, diepe teelaarde maar ook in zandige, stenige gronden.
A2 Tamelijk grote boom (5-10 m)														
Annona glabra (Cayuda)	-	-	X	(X)	X	-	-	X		Vol.	3-7,5m	?	?	Gekweekt. Vochtige gronden.
Balanites aegyptica (Lamunchi shimaron)	XX	XX	-	X	-	-	X	X	--	IJl, sterk vertakt.	5-8m	tot 30cm	Diepgaande, smal vertakte hoofdwortel en oppervlakkige breed gaande zijwortels.	Verscheidene gronden. Slecht op zandige grond. Eerste begroeing op kale diabaashuevels.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN-DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
Cassia fistula (Trosselstok)	-	-	-	-	-	X	-	-		Open kroon met ijl gebladerte.	tot 7m	tot 45cm	Diepgaand	Gekweekt. Tuinen. Verscheidenheid boomvorm.
Cordia sebestena (Caramara spaño)	X	X	-	-	-	X	-	X		Rond, open. Rechtopstaande takken.	tot 7,5m	tot 30cm	?	Stelt weinig eisen aan bodem maar moet droog staan. Gekweekt
Geoffroea spinosa (Palu di taki)	-	-	-	-	X	-	X	-		Open, sterk vertakt. Opgaande takken.	tot 6m	tot 40cm	?	Heeft behoorlijk diepe teellaag nodig.
Gliricidia sepium (Mata raton)	-	-	-	-	-	X	-	-	XX	IJl, onregelmatig breed-uitstaand.	4-6m	20-30cm	?	Gekweekt. Groeit ook in sterk kalkhoudende grond.
Kaninot carthaginensis (Casabi di mondi)	X	XX	-	-	-	-	-	-		IJl, weinig vertakt.	6-10m	tot 15cm	?	In het wild en gekweekt.
Peltophorum acutifolium (Curahost)	X	X	X	-	-	-	-	X		IJl, horizontale takken. Afhangende twijgen.	tot 8m	tot 25cm	?	Alleen in goede humus-gronden.
Ruprechtia coriacea (Mangel di sabana)	X	X	X	-	-	X	-	X		Grote kroon.	7-8m	tot 30cm	?	Alle grondsoorten. Tuin, laan, plantsoen, herbeplanting.
Tabebuia billbergii(T.crysanta) (Kibrahacha)	X	XX	-	-	-	X	-	-	X/-	Zeer sterk vertakt.	tot 8m	tot 45cm	?	Herbeplanting op alle gronden.
Tabebuia pallida (White cedar)	X	XX	-	-	X	X	-	-		Smal, zuilvormig. Dicht-bebladerd.	5-10m	tot 45cm	?	Gekweekt. Verscheidenheid gronden.
Tabebuia pentaphylla (Paarse poui)	XX	X	-	-	-	X	-	-		Sterk vertakt.	tot 7m	tot 45cm	?	Gekweekt. Verscheidenheid gronden mits goed doorlatend.
Vitex compressa (Fuma)	X	X	X	-	X	-	-	X		Sterk vertakt.	tot 10m	tot 30cm	?	Diepe humusrijke teel-aarde. Op hellingen.
Vitex cymosa (Fuma)	X	X	X	-	X	-	-	X		Sterk vertakt.	tot 10m	tot 30cm	?	Diepe humusrijke teel-aarde. Op hellingen.
A3 Kleine boom (tot 5m)														
Adelia ricinella (-)	X	X	-	-	-	-	X	-		Breeduitstaande takken.	2-4m	tot 25cm	?	Kalkhoudende grond.
Annona muricata (Sorsaca)	-	-	-	X	-	-	-	X	X	Slank, dichtbebladerd.	tot 4m	tot 15cm	?	Gekweekt.
Annona squamosa (Skopapel, Kaneelappel)	X	X	-	X	-	-	-	X	X	Onregelmatig. Afhangende twijgen.	tot 4m	tot 15cm	?	Gekweekt en verwilderd.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN-DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
Capparis indica (Palu pretu)	X	X	-	-	X	X	-	X		Compact, koepelvormig.	tot 4m	tot 25cm	?	Alle gronden.
Capparis linearis (Kedebeshi)	X	XX	-	-	X	-	-	X		Zeer ijl. Afhangende twijgen.	tot 3m	tot 25cm	?	Op alle gronden.
Carica papaya (Papaya)	-	-	-	X	-	-	-	X	XX	Vertakt zelden. Bladeren aan top.	2-5m	tot 20cm	?	Gekweekt.
Cassia emarginata (Boonchi largu)	X	X	-	-	-	X	-	-		Vol.	3-5m	tot 25cm	?	Vlakte met goede vochtige humusgrond. Tuin, weg.
Citrus aurantifolia (Lamunchi)	-	-	-	X	-	-	X	X		Breed met afhangende takken. Sterk vertakt.	2-5m	tot 20cm	Oppervlakkig dicht net van zijwortels.	Gekweekt. Verscheidenheid gronden. Vooral diabaasgrond.
Maytenus sieberiana (-)	X	X	-	-	-	-	-	X		Sterk vertakt.	tot 4m	tot 25cm	?	In dalen of aan voet van kalkheuvels.
Syzygium samaragnense (Cashu di surnam)	-	-	-	X	-	-	-	X		Vol.	tot 5m	tot 20cm	?	Gekweekt.

B BREEDGROEIENDE TOT TRAPEZIUMVORMIGE BOMEN

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN-DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
B1 Grote boom ( )10 m)														
Ceiba petandra (Katunboom, Kapok)	-	-	-	-	X	-	-	-	X	IJl. Zeer breed vlak van horizontale takken. Kroon begint hoog.	tot 24m	tot 3m	Bovengronds: plank-wortels. Ondergronds: breed, gespreid	Gekweekt.
Chlorophora tinctoria (Palu dushi di cabei)	X	XX	X	X	-	-	X	X		Vol.	tot 15m	30-60cm	?	Voornamelijk op diabaas-grond. Wegen en grote tuin
Crataeva tapia (Surum di mondi)	X/-	X	X	-	-	-	-	X		Groot, vol.	4-15m	tot 45cm	?	Vochtige gronden.
Spondias mombin (Hoba)	X	X	-	X	-	-	-	-		Breedgetakt, doorgaans weinig takken.	9-12m	60-75cm	?	Alle grondsoorten. Voor-keur voor kalkhoudende gronden.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN-DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
B2 Tamelijk grote boom (5-10 m)														
Anacardium occidentale (Cashu)	-	-	-	X	-	-	-	X		Laag aangezette vertakkingen. Onregelmatige vorm.	tot 9m	tot 15cm	?	Gekweekt. Zandige goed gedraineerde grond, hellingen.
Bauhinia monandra (Vlinderbloem)	-	-	-	-	-	X	-	X		Breeduitstaande takken.	tot 7m	tot 30cm	?	Gekweekt. Tuin. Beschermen tegen harde wind.
Bourreria succulenta (Watakeli)	XX	XX	-	-	X	X	-	X	X	Vol, neerhangende takken.	tot 6m	10-40cm	?	Alle gronden. Vooral op de kalkheuvels.
Bumelia obovata (Placa chikitu)	XX	XX	X	-	X	X	X	X		Vol, sterk vertakt.	tot 8m	tot 50cm	?	Kalkplateaus, zandige stranden, hellingen. Ook andere gronden.
Bursera bonairensis (Palu di sia blancu)	X	X	-	-	X	-	-	-		Slordig, sterk vertakt. Dooreengestrengelde takken.	4-7m	tot 50cm	?	Herbeplanting op alle grondsoorten.
Bursera tomentosa (Takamahak)	X	XX	-	-	X	-	-	-		Sterk vertakt.	6-10m	tot 50cm	?	Verscheidenheid gronden.
Cordia alba (Carawara di mondi)	X	XX	-	-	-	X	-	-		Breeduitstaande takken met afhangende twijgen.	4-10m	tot 30cm	?	Alle grondsoorten. Op lage en onderste gedeelte van hellingen.
Ficus britonii (Mahok di mondi)	X/-	X	X	-	-	-	-	X		Dichtbebladerd.	tot 10m	tot 30cm	? Van takken afhangende luchtwortels.	Iets vochtige gronden. Voorkeur voor kalkhoudende grond.
Guapira fragrans (-)	-	-	X	-	-	-	-	X		Compacte kroon met opgaande takken.	5-10m	tot 50cm	?	Voornamelijk op kalkhoudende grond.
Peltophorum roxburghii(P. inerme) (Flamboyant hel)	-	-	X	-	X	X	-	X	X	Groot, dichtbebladerd.	tot 7m	tot 45cm	Dikke, oppervlakkige wortels. Ontwricht muren, stoep ed.	Gekweekt. Wegkant.
Zizyphus spina-cristi (Apelcas)	X	XX	-	X	-	-	X	X	X/-	Zeer sterk vertakt, bolvormig, compact. Dunne afhangende twijgen.	4-7m	tot 25cm	Extreem diepe penwortel. Spreidende zijwortels.	Alle grondsoorten. Vooral in de vlakte. Gekweekt.
B3 Kleine boom (tot 5m)														
Cercidium praecox (Indju pela)	X	XX	-	-	X	X	X	-	XX	IJl, sterk vertakt.	tot 5m	20-30cm	Oppervlakkig, vernielt stoepen ed.	Beplanting van lagere delen. Wegen, plantsoenen. Gekweekt.

NAAM	WIND BEST.	DROOGTE RESIST.	SCHADUW BOOM	VRUCHT BOOM	SIER BOOM	OPV. BLOEI	DOORN-DRAGEND	BLAD HOUD.	GROEI	BESCHRIJVING KROON	HOOGTE	STAMDIKTE	WORTELSYSTEEM	STANDPLAATS
Erythroxylum havanense (-)	X	X	-	-	-	-	-	X		Sterk vertakt met veel korte stijve twijgen.	tot 5m	Dun	?	diabaas en Knipformatie.
Fagara monophylla (Bosua)	X	XX	-	-	-	-	X	-		Sterk vertakt.	tot 5m	Dun	?	??
Haematoxylon brasiletto (Brazil)	X	XX	-	-	X	X	X	-	—	Open, staat meestal kaal.	4-5m	tot 30cm	?	Kalkheuvels en -plateaus. Diabaasgronden.
Malpighia emarginata (Shimarucu)	X	XX	-	X	-	-	-	X		Bolvormig. Sterk vertakt.	tot 4,5m	tot 20cm	?	Alle grondsoorten.
Parkinsonia aculeata (Boonchi'strena)	X	XX	-	-	-	X	X	X	X	IJl, sterk vertakt. Neerhangende takken.	3-6m	25-40cm	?	Gekweekt. Arme zandige, grind-, of kalkhoudende gronden.
Schoepfia schreberi (-)	X	X	-	-	-	-	-	X		Vol, klein.	3-4m	tot 10cm	?	Kalkhoudende gronden.
Trichilia trifolia (Cerashi sachu)	X	X	-	-	X	-	-	X		Dunne twijgen.	3-6m	tot 20cm	?	Vruchtbare teelaarde. Langs wegen, in dalen.
D CACTACEEEN														
D2 Tamelijk grote boom (5-10 m)														
Cephalocereus lanuginosus (Brebe di pushi, Cadushi di pushi)	XX	XX	-	-	-	-	X	X	X	Zuilcactus. Weinig vertakt.	tot 8m	15-25cm	Breed, oppervlakkig.	Alle gronden. Droog.
Lemaireocereus griseus (Datu)	XX	XX	-	-	-	-	X	X	X	Zuilcactus. Minder vertakt dan Cereus repandus.	tot 10m	tot 35cm	Breed, oppervlakkig.	Alle gronden. Droog.
Pereskia guamacho (Guamacho)	X	X	-	-	-	-	X	-		Boomcactus. Ronde kroon.	3-10m	40-60cm	?	Gekweekt. Singel.