Starting a Nursery or Herb Farm

third edition | **John Mason**

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NOTE

The information in this book is derived from a broad cross section of resources (research, reference materials and personal experience) from the authors and editorial assistants in the academic department of ACS Distance Education. It is, to the best of our knowledge, composed as an accurate representation of what is accepted and appropriate information about the subject, at the time of publication.

The authors fully recognise that knowledge is continually changing, and awareness in all areas of study is constantly evolving. As such, we encourage the reader to recognise that nothing they read should ever be considered to be set in stone. They should always strive to broaden their perspective and deepen their understanding of a subject, and before acting upon any information or advice, should always seek to confirm the currency of that information, and the appropriateness to the situation in which they find themselves.

As such, the publisher and author do not accept any liability for actions taken by the reader based upon their reading of this book.

PREFACE

If you've ever wanted to grow plants for a living, put your gardening talents to good use, or start your own business, this is the book for you.

Today there is an unprecedented interest in gardening, houseplants and in the use of herbs (for purposes both culinary and medicinal), and a nursery or herb farm can represent a viable small business proposition.

In this book John Mason, an experienced nurseryman and horticultural educator, explores the possibilities open to you. He examines many alternative methods of operation, including the wide variety of product types, and discusses techniques of management and planning. There is detailed coverage of equipment and materials, dealing with plant health problems, and techniques of propagation - both from seed and by budding, grafting etc. Indeed there is much here of value to the home gardener, including a unique feature of the book - a guide to the methods of propagation of over 400 species of plants.

Whether you plan to begin on a modest scale in your back yard or to make a substantial investment, careful forethought is needed.

John Mason deals with all the points that need to be considered before you start stressing at every stage the various decisions which should be taken to avoid problems later on.

Starting a Nursery or Herb Farm is a book that will not only multiply your chances of success but remain a valuable reference for many years.

JOHN MASON graduated from Burnley Horticultural College in 1971. Since then he has run his own nursery, worked in landscape design, held the post of Superintendent of Parks and Gardens in several Melbourne suburbs, been a part-time lecturer at Footscray Institute ofTechnology, Burnley Horticultural College and the Council of Adult Education in Melbourne, and a consultant on children's playgrounds for the Playgrounds and Recreation Association of Victoria. John is also the author of over 40 books and now runs ACS Distance Education, a correspondence school teaching courses in an huge array of subjects.

INTRODUCTION

This book is written as a guide or handbook for the person attempting to start or run a nursery or herb farm. It does not give all the information you might need or want but it does cover all the important aspects of the topic.

Use this book as a guide, a starting point maybe a reference to come back to, but look at other information as well.

Study closely the herb farm or nursery industry in your part of the country. Speak with appropriate government departments such as agriculture, forestry and CSIRO. Speak with horticultural clubs, colleges and schools. All of these places can help you with the detailed information you need to acquire about your chosen sector of the industry.

It is very important for you to realise that there are tremendous variations in the way plants are treated from place to place. Information in this book is relevant to 'average' Australia or New Zealand, if there is such a place.

In general, information is relevant to climates similar to Sydney, Adelaide, Perth, Canberra or Melbourne. In warmer or cooler climates, you may need to modify the recommendations to some extent.

Always remember that every plant is an individual. Ten different plants grown from the same batch of seed are different They differ in their shape and growth rate, their disease resistance and their nutrient and water requirements. Bear in mind also that the same plant requires different treatment in different places and at different times of the year.

Whenever reading any book on gardening (propagation or any other discipline), consider where the author has gained his experience. Information written by a Melbourne gardener, unless stated otherwise, is probably only fully relevant to Melbourne.

Any herb farmer or nurseryman is going to need to use several books for reference and it is important to know that the reference books are accurate. Once again consider the author, their background and their training. The most likely books to provide credible information must always be those written by people with solid academic training plus extensive practical experience in the subject. There are many valuable publications written by people who have only the practical experience.

Beware of books written by artists, journalists and engineers, who sometimes write gardening books simply because they're interested in the subject and happen to have the 'contacts' through writing on other subjects. A gardening book by an artist or architect can be a beautiful coffee-table publication, but in terms of accuracy for reference, can lead to disaster.

PLANT CLASSIFICATION

Despite the fact that every plant is an individual, some plants do share characteristics to a greater or smaller degree, and they are classified on the basis of such similarities. Plants are known by both common and scientific names.

Unfortunately, the same plant can often have many different common names or many different plants can have the same common name. This situation has, in the main, made the use of common names confusing and often unreliable.

The confusion is not so marked with herbs, however - perhaps because of their long history of use - and herbs are often sold only under the common name, whereas most other plants are usually grown and sold under their scientific name.

Scientific names, being in Latin, may initially be more difficult to learn, but they are totally reliable.

Any one plant has only one scientific name. In this system, plants are classified by dividing them into groups with similar characteristics; these groups are then divided into groups with even closer similarities and so on.

There are seven levels of division:

- All plants are divided into several *phyla*
- Phyla are divided into *classes*
- Classes are divided into *orders*
- Orders are divided into *families*
- Families are divided into *genera* (singular: *genus*)
- Genera are divided into *species*
- Species are divided into *varieties*

When identifying a plant we use the genus and species names (and if applicable the variety) e.g. Eucalyptus (genus) camaldulensis (species).

Correct identification and labelling of plants is essential. Help with the identification of plants can be obtained from botanic gardens, university botany departments or your government herbarium (in most capital cities).

THE ALTERNATIVES

There are a number of very basic decisions which need to be made before commencing a herb farm or nursery operation. These alternatives should be reconsidered every year' or two through an operation, and perhaps changes made accordingly. These first decisions are discussed in turn below.

FORM OF PRODUCT

Most nurseries and herb farms specialise in one or two of the following products.

Plants in Pots

This is the way the major part of the herb farm and nursery industries operates. The scale at which this sector of the industry operates makes growing in containers a low-risk operation compared with some other alternatives. Plants in containers do, however, become potbound and need to be sold or else potted up within a certain time.

Plants in the Open Ground

Plants are grown in cultivated paddocks until ready for sale, at which time they are dug up and prepared for sale in various ways:

- they are put into containers
- soil is removed from the roots (deciduous plants only) and they are stored over winter with roots in moistened shavings or straw
- the soil ball is held together by tying hessian around it
- in some heavier soils, plants are sold with whatever soil clings to the roots left as such, not contained in any way by cloth or any other container

After container growing this is the next most common practice.

- Open-ground growing is economical in that it doesn't require the same expense for containers and usually it calls for less watering.

Bare Rooted Cuttings

Some nurseries specialise in propagation, that is producing roots on cuttings. They leave the job of growing the plants up to a saleable size to another nursery.

This type of operation requires less area but more expertise and a greater initial outlay on expensive propagating structures and equipment.

Specialised Container Products

Hanging baskets, terrariums, bonsai mini-gardens and plants in decorative tubs are all products in which a nursery can specialise. Before commencing this type of operation however, study carefully the demands of the market and know what competition exists.

You also need to be sure you know how to produce your product and how to produce it well. Anyone can make a bonsai but it takes skill to make a good one which will survive.

Herbal Products

There is a definite growth in demand for such things as dried herbs, teas, oils, candles and pillows. Compared to the broad nursery industry, however, this industry is minute. You should be careful about depending too heavily on this type of operation. It is more sensible to start as a sideline and grow, than to throw everything you have into producing a line of herbal products.

Plants grown in the open ground may be sold in several ways including, as shown here, with a soil ball attached to the roots eg. bare rooted (Dahlia bulbs).

Herbal products such as cosmetics, herb vinegars, pomanders, and dried herbs for cooking are becoming ever more popular, but do not rely on them heavily at first - business may take time to build up.

GROWTH STAGE

At what stages of the plant's development will you be handling the plant? The answer could be either one or a combination of the following stages.

Propagation

The beginning of the plants life: seed is sown, a cutting is struck, bulbs are divided or a fruit tree is budded etc. This stage requires greater technical skill and, in some cases, more expensive equipment than other stages.

Planting Out

The small propagated plants are put into pots, planted into the open ground or into some other situation in which they can be grown to a larger size. There is more difficulty at the beginning of this operation when the plants are moved from a pampered propagating environment to a harsher growing-on environment. As they become older, they harden and become more resistant to disease and environmental problems.

Advanced Growing

This involves growing plants to a large size either in containers or the open ground. Though these plants might be hardy, this type of work is heavy and usually requires at least some machinery to handle the plants.

Many nurseries supplement their sales of plants with ancillary

products - pots, window boxes, watenng cans, and various sprays and treatments.

QUANTITY

On what scale will you operate? Will it be a one person part-time or fulltime business or will several people be engaged full-time? The quantity of plants handled annually will depend very much on the stages of the nursery or herb farm operation (outlined above) in which you are involved. A propagation nursery needs to produce up to 100,000 cuttings a year to be a reasonable operation for one person. A nursery which does everything from propagation through to retailing can be a feasible operation for one individual producing as few as 10,000 plants a year.

QUALITY

This raises such questions as the type of label (with a photograph, printed or simply handwritten, type of container cheap plastic bag simple solid plastic pot or better-looking plastic pot), whether plants are sold with a stake or trellis, and whether plants will be pruned to shape as part of the growing process. Will plants which don't thrive be thrown out or still sold? Will plants which are potbound be sold? It is not necessary to decide all these details at the planning stage, but you should formulate a general policy on quality.

SELLING

The first decision to make is whether your operation is to be wholesale (selling to retailers or resellers) or retail (selling direct to the general public). Retail operations are generally more demanding in terms of time, but give a better return per plant. A retail nursery or herb farm must be attended at the advertised opening times irrespective of whether customers are there or not. It is difficult for someone running a one person retail operation ever to have time to take a holiday, whereas a wholesale nurseryman needs only to employ a person on a part-time basis to do some watering when he takes annual leave.

You should aim at growing your produce for a particular market. Consider the following alternatives:

- your local area, your region or perhaps interstate. Interstate sales (southern states) are appropriate for 'indoor' or tropical plants grown in Queensland
- bulk users of plants such as council parks departments, housing estates, landscapers, farmers etc.
- supermarket chains and other large business organisations
- home gardeners. Even here you may decide to aim at inner suburban, outer suburban or country markets

Plants can be sold both retail and wholesale by a number of alternative methods.

Mail Order Sales

Sales are conducted either by advertising in magazines or by sending lists or catalogues to prospective customers through the mail. Most plants can be sent successfully by rail, road or mail, but it is very important that they are packaged in a proper way to avoid damage.

Roadside and Market Sales

These involve setting up a temporary stand which you operate only when you have something to sell. This type of operation is usually small-scale, but can be a very worthwhile supplement or contribution as a part income. It is rarely, by itself, a satisfactory way to earn a complete income.

Permanent Outlet

This is the most common, most demanding and most profitable way of conducting any type of sale.

Truck Sales

One ofthe most common wholesale selling methods is to make regular visits to a round of retail establishments in a truck carrying a selection of plants or other products. The retailers view the merchandise and buy direct off the truck. This system can be difficult for the beginner, but once you learn what plants or herb products are most likely to sell, then you can be almost assured of complete sales before starting your round.

Contract Sales

Some government departments, supermarket chains and other large organisations will enter into contracts with nurseries to propagate and grow specified numbers of certain varieties of plants. Some retail or 'growing-on' nurseries will sign contracts with propagation nurseries to supply them with plants at some future date. This way of selling is more certain for the nurseryman, but usually pays less per plant

The greater part of the nursery industry operates by selling plants in pots. Seedlings, especially vegetables, may be grown in trays and sold for planting out simply wrapped in cloth or newspaper.

Export Sales

Australian nurseries began exporting plants to a number of countries in recent years. Both independent and government reports indicate enormous potential for export sales of Australian grown plants, especially Australian natives.

Market sales can yield a useful supplementary income, but are rarely sufficient to provide a living.

MANAGEMENT AND ORGANISATION

To work efficiently and profitably, a nursery or herb farm must be both well organised and properly managed in a clear conscious manner. As with most other businesses, it is essential to be confident enough to make firm clear decisions when they are needed. The nurseryman or herb farmer who hesitates too often or takes too long to make decisions is almost certain to fail.

SELECTING THE SITE

It is not always possible to have the ideal site. Sometimes a piece of land is already owned or perhaps financial limitations force a compromise. Important considerations are discussed on the following page.

To Own or Rent?

If money is to be borrowed for any part of the operation, land is a better proposition for a loan than most other things. You should consider the permanency of your operation. Land ownership is considered a less flexible means of operation than renting. Renting. however, can be an insecure form of tenure.

Size of Site

Generally, nurseries or herb farms require significantly less land than other types of primary production. Propagation nurseries and retail operations can be successfully conducted on sites of less than one acre. Standard container growing of herbs or other plants is usually conducted on a couple of acres. Some of the largest container nurseries in Australia are able to run on less than five acres because they are carefully organised and managed. Open-ground nurseries can be anything from a couple of acres to several hundred acres.

If your site is not ideal you can at least make the most of it: terracing using railway sleepers to create beds in the sloping ground. Use windbreaks to protect plants in open places

Proximity to Market

If retailing. the operation is best located on a major road travelled frequently by large numbers of prospective customers or, alternatively, in a centre which is frequented by prospective customers. Avoid locating too close to similar existing businesses. If wholesaling. locate within reasonable proximity to customers or to existing transportation networks (e.g. a mail-order nursery selling throughout Australia could successfully establish close to any reasonable railway station).

Availability of Water

All plants need water to grow, but some need more than others. A reliable source of unpolluted, salt-free water is essential.

Fertile Soil

This is only really important when growing in the open ground. Good container nurseries can be established in very infertile areas.

Climate

If establishing in an unsatisfactory climate for the plants being grown, extra expense will need to be incurred on developing climatic controls (glasshouses, windbreaks and shadehouses).

Availability of Materials

In container nurseries, in particular, it is important to be close to a reliable source of material which can be used in potting mixes. Cartage costs on sand, loam, lignite, pine bark and other such materials can be significant, and you may be charged for every kilometre each cubic metre of material is carted.

A successful nursery business does not necessarily require large premises: this setup operates from a house block in the middle of a city.

Many shops supplement their sales with a nursery department, and an outside display can secure many casual sales to passers-by.

SELECTING THE CROP

All too otten, people enter horticulture with very definite prejudged ideas on what they will grow, where they will grow it and how they will grow it. While such people have a real advantage in that they obviously love that particular type of plant they can only benefit by giving objective consideration to *all* the alternatives.

Crops grown by nurseries fall into the following broad categories:

INDOOR OR TROPICAL PLANTS:

Grown outside in the northern parts of Australia; the same are often grown indoors in cooler parts.

NATIVES:

Plants indigenous to Australia.

PERENNIALS:

Soft-wooded (herbaceous) plants grown for decoration.

BULBS:

Also corms, rhizomes and tubers grown for flower, often with perennials.

EXOTIC ORNAMENTALS:

Woody plants not native to Australia grown for nonproductive or amenity purposes. Often nurseries specialise in one particular group of exotics (e.g. azaleas, geraniums or cacti).

Deciduous fruit tree nurseries usually also grow deciduous ornamental trees which require similar techniques and treatment. Some specialise in citrus or berries.

The principal choice facing the herb farmer involves the form in which the crops will be sold:

PLANTS FOR SALE:

Either grown in containers or in the ground.

CROPPING:

Herbs grown *en masse*, the foliage being cropped and perhaps dried or oil extracted for sale.

HERB PRODUCTS:

Growing plants to provide the raw material to produce a range of herbal products (e.g. teas, dried herbs, candles and preserves).

When considering the alternative crops, there are a number of questions to which you must find the answers. How well does the product keep? If it can't be sold immediately, can it

be potted up? Will it still be saleable in a month or a year?

How long does it take to become saleable? Some operations (e.g. selling 5 cm tube-size plants) can give a return in three

or four months from starting, while others (e.g. citrus trees) can take up to seven years from starting the rootstock to selling the budded plant

What will be your peak work times? Different types of operations will impose heavy or lightworkloads at different times of the year. Deciduous plants require budding in February-March and digging for sale in winter. The remainder of the year is lighter work. Retail nurseries or herb farms are very busy in spring and to a lesser degree in autumn, although summer is very slow.

Working in groups is congenial, but is not necessarily the most efficient way of completing a task. Sensible management of labour time can mean the difference between success and failure.

Starting small is always a wise policy - a small greenhouse or shadehouse of brush has been built to allow for expansion. The tree in the comer gives useful extra shade.

What are you most capable of doing? Don't attempt to grow difficult plants if you are relatively inexperienced. Don't grow indoor plants in Melbourne unless you have the glasshouses to do so.

What demand exists for the product? Is that demand constant or is it likely to increase or perhaps decrease?

Will you specialise or combine a number of different alternatives? There is a tendency toward specialisation but perhaps for the beginner, a more general approach is of less risk.

What will be the costs and initial outlay, and how do they compare with the return? Some types of operation (e.g. indoor plants in cooler climates) require very large initial outlays.

Running a nursery involves many hours of repetitive tasks, and the importance of a pleasant and spacious working environment should never be underestimated.

LAYOUT

In any nursery or herb farm, the plants or herb products that leave the site are the culmination of many different stages. An efficient operation necessitates a smooth and easy flow from one step to the next. It is necessary to identify the various components (e.g. seed or cutting material, pots and potting mix) which are coming together to produce the final product. These components must be arranged so that they come together and move through the operation with the minimum of effort.

When planning the layout of your operation, you should decide on the areas needed for different tasks. The nursery plan should include adequate space for the following:

- stock plants (plants from which cuttings and perhaps seed are collected)
- store for pots, fertiliser, barrows and the like
- soil bins for material to be used in potting media
- propagation area where seed and cuttings are planted into pots
- glasshouse for getting seed and cuttings started
- area for mixing potting media
- potting-up area
- growing-on area, where plants are grown to full size after seed or cuttings are put in individual pots
- despatch area where orders for wholesaling are collected and loaded onto a truck for despatch.

It is important to have different work and storage areas integrated into a flow pattem so consider the relationship between these areas and decide their relative proximity.

For example:

- the propagation and potting-up areas could possibly be in the same place
- the store needs to be near a road so that delivery vans can easily unload
- the soil bins also need easy access to roads
- the soil bins should be located adjacent to the area for mixing potting soils
- the area for potting up should be adjacent to the area for growing on, which in turn should be adjacent to the area for despatch.

Decisions such as these should be made and written down. Take a plan of the site as it exists showing fixed features such as buildings, water pipes, electricity wires, fences and trees, and try to arrange the various areas to achieve most of the desired relationships you have decided upon.

Once the approximate location of each area has been decided the fine detail of the way each area is to be organised can be worked out.

MANAGING MANPOWER, EQUIPMENT AND MATERIALS

No matter how tedious it might seem, it is essential that you write things down on paper. When starting a new operation, planning is required for manpower, equipment and materials both in terms of the amount required (otherwise you have too much or too little) and how they are best used.

Later, in the day-to-day operation, records need to be kept not only for the tax man, but also to provide information which can be used to review the progress of the operation. This paperwork falls into two categories - plans and records.

You must keep complete records of income and expenditure (both for tax purposes and as a guide to your success or failure). Records should also be kept of materials purchased and used, staff (if someone is fired make a note), accidents and production rates (how many plants are potted in a day etc.). These records can become very useful in the future.

Plans include scheduling work and making decisions on the equipment which will be required and on the way in which the nursery or farm will be expanded. It is very easy to find yourself making plans like this in your head without putting anything down on paper. It is, however, only when plans are worked through on paper that they can be seen in a proper perspective.

A work schedule should be designed to achieve the following objectives: Work should be completed for the minimum cost possible without compromising standards. When more money needs to be spent on labour to achieve only a little more work, something is wrong.

Work should be completed in minimum time. In nurseries or herb farms, the worker can easily be distracted and become involved in unnecessary fussy tasks - such as smoothing out the surface of the soil mix in the pots while potting up.

A certain standard should be stated and worked towards. Plan to pot up a certain number of plants or put in a certain number of cuttings per hour.

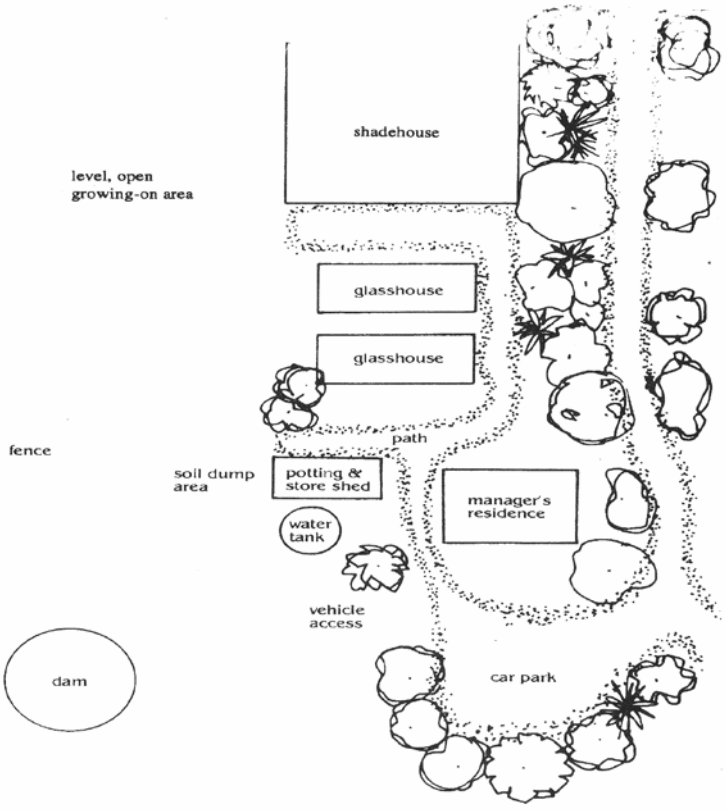
The work schedule should be designed to spread the work load evenly throughout the year. Tasks which can be completed at any time (e.g. cleaning out a store or building a new dam) should be scheduled when other work is at a minimum.

When scheduling, give thought to the availability of materials and equipment so that shortages do not prevent the schedule from being met.

The schedule should be easy to read and comprehend. The boss and the employees must both be very clear on what is expected of them and when. There should, of course, always be room for the schedule to be altered when this becomes necessary, and staff need to be clear on this possibility.

The following steps represent a useful basic procedure for scheduling.

1. List all the tasks to be carried out over a 12-month period (potting up, cuttings, seed, selling and weeding).
2. Calculate the estimated number of man-hours available over a 12-month period (e.g. one person full time for 50 hours a week with two
3. Weeks' holiday would give 2500 hours of work).
4. Allocate the hours available to the jobs needed to be done.
5. Make up a table on a large sheet of paper listing the tasks or jobs in the column on the left-hand side and the weeks ofthe year across the top.
6. Allocate the hours available to each task throughout the weeks of the year in a way which will spread the work as evenly as possible throughout the year.



PROPAGATING TECHNIQUES:

AN OVERVIEW

Broadly, there are two ways of propagating plants - asexually and sexually. Asexual propagation involves growing a new plant from some part (e.g. leaf, stem and root) of an existing plant This is also known as vegetative propagation because it uses the 'vegetative growth' of the parent plant to produce the 'daughter' plant.

Sexual propagation involves fertilisation of female plant parts by male parts to produce seeds or spores from which new plants are grown.

There are many different reasons why we might choose to propagate plants one way rather than another:

- the availability of propagating material (can you get plenty of seed or cuttings?)
- ease of propagation (which technique is the easiest?)
- speed of propagation (which technique produces new plants quickest?)
- importance of maintaining true characteristics (plants grown from seed can differ from their 'parent plant in terms of colour, shape, size etc. Asexually propagated plants do not vary in this way).

SEXUAL PROPAGATION

Following are the most important considerations when attempting to germinate seed or spores.

Provision of a Correct Environment

Requirements here can vary considerably from plant to plant Drainage and structure of your propagating mix. amount of watering, temperature and light (or dark) can be important for success. For most seed (but not all), an ideal mix would be 75% coarse propagating sand plus 25% of either peat moss or vermiculite. Most seed is best germinated under glass.

Pre-germination Treatments

While some seeds will germinate immediately in the correct temperature and moisture conditions, others have to be treated in some way first.

Both callistemon and melaleuca require no pre-germination treatment but it may be necessary to heat the seed cases gently in an oven before the seed can be extracted.

Kennedia, Acacia and Hardenbergia are legumes with beanlike seeds which require hot-water treament to stimulate germination.

Seeds from the Proteaceae family (e.g. hakea and banksia) are extracted from woody fruits by placing in a warm position. Fruits then open and drop seeds.

Many Australian natives (and some overseas plants) have extremely hard seed coats which must be broken physically, usually by burning or treatment with hot water. Some plant seeds contain chemicals which inhibit seed germination: these inhibitors must be leached out of the seed before it will grow. Many deciduous trees and conifers will not germinate from seed until the seed has been through a period of coldness. Such seeds are usually stored in the refrigerator for a period before planting.

Protection From Disease

Plants are most susceptible to disease in the early stages of life. One of the most common causes of failure of seed propagation is attack by fungal disease. These problems are most likely to occur in poorly drained mixes, unclean mixes (keep your propagating area equipment and soils free of disease), overcrowded seed trays and pots, or badly ventilated areas. These diseases spread very rapidly - they can appear one morning and within the space of one day kill thousands of plants.

ASEXUAL PROPAGATION

Here are the main methods of asexual propagation.

Tissue Culture

This is a highly technical method in which microscopic pieces of a plant are cultured or grown under laboratory conditions. Tissue culture allows propagation of very large numbers of plants from one single plant within a relatively short space of time. Because of this advantage tissue culture has become a very important technique in some sections of the nursery industry. Tissue culture requires a much greater degree of expertise than could be presented in this book. If you wish further information on this technique, I suggest you contact your State Department of Agriculture or Primary Industry.

Runners

A runner is a trailing growth, extending from a plant above the ground, which takes root and produces new plants along its length. Examples of plants that produce runners are strawberry and Chlorophytum.

Suckers

Suckers are growths which spring from the base (below ground) of existing plants. Plants grown from suckers will tend to sucker more than plants of the same variety grown by some other technique.

Raspberries are grown from suckers because it is desirable to have plants suckering.

Poplars, while easy to grow from suckers, are best grown in other ways because suckering trees are undesirable.

The 'piggyback plant' (Tolmia menziesii) develops shoots at the base of the leaves, and is propagated by cuttings known as 'leaf offset'.

Separation

In this situation, plants naturally produce completely new offspring at the base of existing specimens. Separation simply involves breaking these clumps apart; examples are daffodil, tulip, gladioli, hyacinth and crocus.

Division

Some plants grow in such a way that one individual plant can be cut into sections and each section will grow as a new plant; examples are phlox, canna, iris, dahlia and potato.

Layering

Layering involves promoting the growth of roots on a stem while it is still attached to the parent plant. Once these roots establish, that section of the plant can be cut away and planted as a new plant. The main advantage of layering is that it does not risk the loss of propagating material if the operation is unsuccessful.

Budding and Grafting

These techniques involve attaching a part of one plant onto another plant in such a way that the two will grow together. The end result of budding or grafting is a plant which has one variety for its root system and a different variety for its top. This is a valuable technique in many situations, e.g. growing a variety that is susceptible to root disease on a resistant root system.

Cuttings

Cutting propagation is by far the most commonly used asexual technique. It involves inserting a section of a plant in a soil mix to promote leaf and root growth.

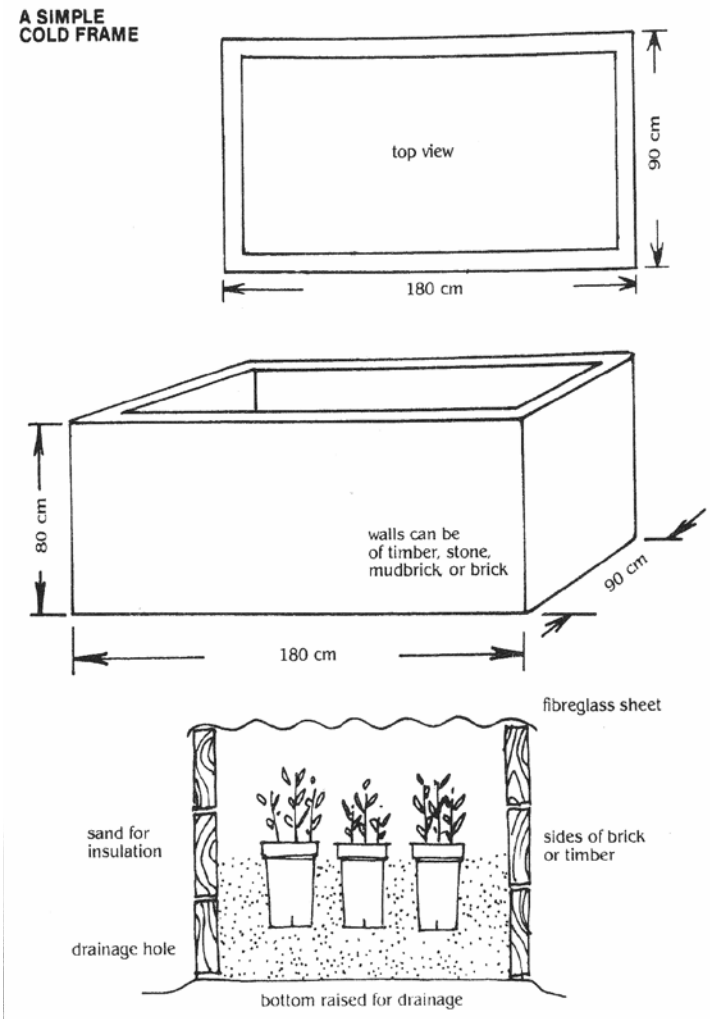
There are four types of cutting:

- **STEM CUTTINGS,** which use a section of stem with most of the leaves removed.
- **ROOT CUTTINGS,** which use a section of the root
- **LEAF CUTTINGS,** which use either a whole leaf or section of leaf.
- **LEAF BUD CUTTINGS,** which use one leaf attached to a very small section of stem with a bud.

Techniques of sexual and asexual propagation are covered in detail in Chapters 7 and 8.

PROPAGATING STRUCTURES AND EQUIPMENT

Two main types of facilities are used in propagating: facilities for initial propagation, which control temperature, light and water conditions to promote seed germination or root formation (e.g. a glasshouse); and facilities for hardening off which are structures for housing young plants after the initial propagation, providing an environment a little harsher than that used for propagating but more protected than their eventual environment (e.g. a shadehouse).



Cold Frames

In essence, a cold frame is simply a small glasshouse, so small that a person can't get inside it. Cold frames are the simplest and cheapest of all structures. A very basic type can be made by piling bricks one on top of another to form four walls (a box-type arrangement), 50-100 cm (20-40 in) high. A sheet of PVC, fibreglass or glass is placed on top to complete the construction. A wide variety of seed and cuttings can be started in such a simple construction. In my first nursery, I grew around 10,000 plants a year all started in a 2 m by 1 m cold frame made this way. .

The construction of any cold frame is as above - a box with a top which allows penetration of light. The top should always be a clear material allowing the full spectrum of light to penetrate. Do not use colored PVC; use only clear or white PVC or fibreglass.

Obvious improvements can be made to any cold frame by making a more solid construction, by insulating the sides (and perhaps underneath) and by hingeing the top. Not so obvious improvements are:

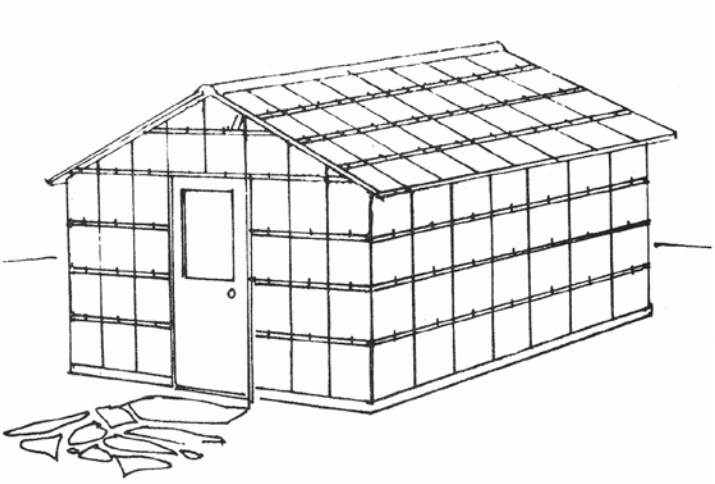
- slope the top slightly facing north so that a greater amount of the sun's energy will be caught
- place heating and misting controls inside the frame (see later in this chapter)
- place about 25 cm (10 in) of coarse sand in the bottom of the frame The pots of cuttings or seed put into the frame can then be buried, providing partial insulation for the root zone of the developing plants.

Apart from being used alone as a propagating unit cold frames can also be used:

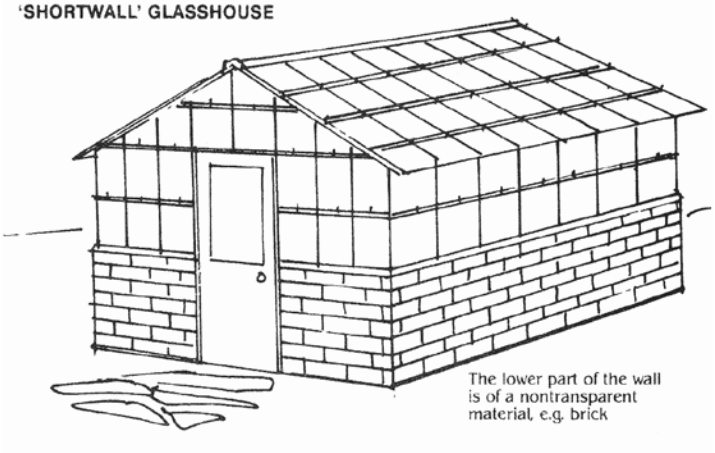
- inside a glasshouse as a method of providing increased environmental control
- as a facility for hardening off plants which have been started in a more pampered glasshouse environment
- if detachable tops are made, they can be replaced with tops made of shadecloth, turning the cold frame into a mini-shadehouse

Glasshouses

There is an overwhelming number of possibilities open to anyone planning to use a glasshouse, not the least being to change your mind and not have one at all. While glasshouses are necessary for growing some types of plants in some areas, it is quite possible to operate some types of nurseries without a glasshouse. Consider the alternatives outlined below before deciding on any type of glasshouse.



'SHORTWALL' GLASSHOUSE



Some glasshouses, belonging to established seedling nurseries, looks built to last; in fact the construction can be unsatisfactory, giving rise to wind problems, and the trusses can be found to be too weak.

When starting off you may need nothing more elaborate than a home gardener's aluminium-framed kit glasshouse.

Type Of Construction

The simplest is a lean-to, usually situated against a north wall or fence in order to catch maximum light and heat.

The most complex and expensive is an even-span gable-roof building using glass panels in a timber or metal framework. This type of house can either be "long wall" (with glass extending to ground level) or'short-wall' with the bottom half of the wall constructed from a non-transparent material such as cement sheet or brick). Long-wall houses allow greater light penetration, but sometimes retain less heat at night.

Other construction alternatives include uneven-span gable, flat-roofed, single-span sloping-roof, geodesic-dome and polythene-film tunnel glasshouses. Of these, the polythene-film tunnel house has become extremely popular in recent years, particularly for new nurseries, because of its low cost. This structure consists of a metal framework covered by a sheet of polythene. The framework can be used over and over but the polythene sheet needs to be replaced every two years.

The effects of heavy frosts can be felt a short distance inside the walls of this type of house, thus making it unsuitable, in at least some areas, for

growing tropical or indoor plants. This problem can be minimised by covering the house with two layers of polythene. The thin layer of air between the sheets greatly improves insulation.

Wall and Roof Material

Nowadays a wide range of materials can be used for glasshouse construction.

- **GLASS** is very effective, and represents the most permanent of the alternatives. It is expensive, however, and also a little more complicated for the beginner to work with than other materials.
- **COREFLUTE -** also known as 'solar sheet' - consists of two sheets of plastic separated by an air space and bonded by thin plastic strips. It is cheaper than glass but still comparatively expensive; a I5-year lifespan is claimed but remains to be proven. Heat retention is better than other plastics.
- **FIBREGLASS** is more expensive than PVC but has a longer lifespan. Use only clear sheet (not coloured), approx. 2 mm thick - usually sold as 1800 g per m2. The main disadvantage is that light transmission decreases with time.
- **PVC SHEET** is excellent in the short term but cracks after 4-S years (less durable in northern states). The surface tends to collect dust which reduces light transmission.
- **POLYTHENE FILM** loses more heat at night than alternative materials. Durability is usually no more that

two years. Use only ultraviolet-ray-resisting polythene. There is no limitation on size or shape (it can be welded into sheets of any size).

- **POLYCARBONATE** is relatively durable, rigid and non flammable material which is generally longer lasting than amny other plastic-like materials.

Floor

For young plants it is essential to provide a clean environment to minimise the likelihood of disease. If the house is to be used for propagation or growing difficult species, the floor should be concrete or some easy-to-clean surface. An acceptable but less desirable alternative is coarse gravel or chipped stone which is free draining. as this allows disease to be washed away. Woodshavings have been used as a floor surface but unless you are dealing only with hardy species, this is a risk. If plants are on benches, the surfacing is less critical.

Orientation

In the past glasshouses have been on an east-west orientation, following European practice, but expert opinion has recently suggested north-south might be better. No firm recommendation is widely accepted in Australia.

Ventilation

Plants require fresh air to grow properly. This can be provided in various ways: vents in the lower wall of a short-wall house; vents along the top rim; windows in the walls; doors or forced ventilation using fans.

In houses less than three meters wide, vents relying on natural air movement are adequate; above this, forced ventilation is needed. The size of vents required can be calculated thus:

Vent area (in m^2) = **Glasshouse volume in m^3/180**

Always locate air inlets in positions away from the plants. Fresh cold air from outside can damage plants.

Cooling

The growth rate of plants can be reduced by high temperatures as well as low ones. Aim to keep the glasshouse temperature below 30°C.

Ventilation - opening vents or doors - obviously helps, but is ineffective on a hot day without wind.

Shading can be achieved by applying whitewash - usually two or three times over the summer months (it is removed in winter). Alternatively, a roll of shadecloth or blinds can be used. Shading helps, but alone is not always enough.

Water - intermittent sprays of water mist, watering the walls and roof or flooding the floor - will lower the temperature. Be careful not to overwater the plants.

Refrigerative COOLING is effective but rarely used because of the expense.

Evaporative COOLING operates by drawing air over a wet pad. The water absorbs the heat from the air. This system is usually controlled by a thermostat.

Heating

Temperature requirements do vary from species to species but in general glasshouse temperatures should be kept between I5°C and 50°C to achieve maximum growth. Never let the temperature drop below 5°C. Various methods of heating can be used.

HOT-WATER HEATING SYSTEMS pipe water from a boiler through a series of radiators.

STEAM HEATING is based on the same principle as hot-water heating. It has the advantage of producing steam which can be used also for soil sterilisation.

DUCTED AIR can be adapted to most energy sources; it is expensive but effective.

FAN HEATING consists of an electric heating element built into a casing with a propeller fan blowing air past the element.

KEROSENE BURNERS of the ordinary household type have been used as a cheap and easy-to-set-up form of heating. The main disadvantages are the fumes and the difficulty in controlling temperature changes.

TUBUIAR ELECTRIC HEATERS, consisting of 50 mm diameter water and acid-proof tubes containing electric heating elements, are suitable for small glasshouses (easily installed and fitted with a thermostat), but are generally not powerful enough to heat larger ones.

Two popular methods of glasshouse heating - electric fan heaters and a kerosene burner. Kerosene is less suitable, though it has economic advantages.

Irrigation

This can be one of the most time-consuming activities in any nursery, both inside and outside the glasshouse.

MANUAL WATERING is extremely labour intensive.

A MANUAL FIXED SYSTEM involves fixed sprinklers which need only to be turned on and off. This reduces the labour requirement greatly, but someone must still be there to turn them on and off. You can't leave the nursery for any length of time!

In an **AUTOMATIC FIXED SYSTEM** the sprinklers are controlled, usually by some ectrical device, so that the watering can take place even if no-one is about. This is expensive but in the long run saves greatly on time and effort.

PROPAGATING BEDS

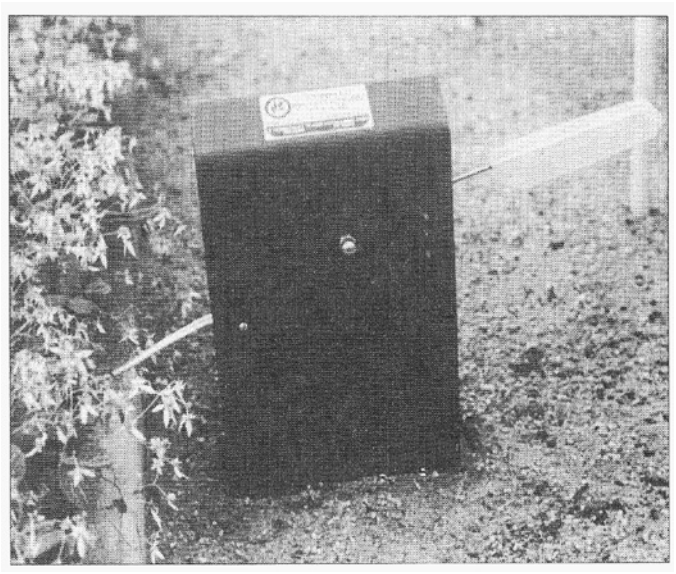
Usually seeds and cuttings are started in a specially constructed bed. Since young plants are more susceptible to disease, this bed should always be the cleanest of all areas in the nursery.

The simplest type of propagating bed is a basic cold frame as described earlier in this chapter. Often a cold frame structure inside a glasshouse is used for propagating.

The efficiency of a propagating bed can be increased greatly by introducing misting and/or bottom heat. The principle behind both is the same - that the part of the plant which is warmest tends to grow a little more quickly; therefore, if the top of a cutting can be kept cooler than its base, the cutting is likely to produce roots more quickly.

MISTING involves spraying a fine water mist over the plants at controlled, frequent intervals, cooling the tops of the plants.

This mysterious black box is an automatic on/off control for a misting system. Spray falls on the wire-mesh 'leaf' and weighs it down, which switches off the mister. As it dries the leaf rises, and the spray is switched on again.



BOTTOM HEAT is provided usually by low-voltage electric wire, sometimes by piped hot water or occasionally by mains-connected cables (insulated heating element) running under the pots through sand, perlite or some similar material which is used to fill the bed.

By covering an electrically heated propagation tray with shadecloth it can be used as a mini-shadehouse.

The mini-propagator with bottom heat is the cheapest type available, but it has no thermostat and needs to be checked constantly and switched manually on or off as required. This is a considerable disadvantage.

SHADE HOUSES

These are used for two purposes: to act as a staging post between the protection of the glasshouse and the full exposure of the open nursery rows, and to protect plants from extreme temperature, light and frost in harsher climates or at certain times of the year. In some situations, it is a practice to have the house covered with the shade material only at those times of the year when protection is needed most

Many different materials have been used for shading but today the woven synthetic shadecloth has all but replaced the other alternatives.

Brush and hessian shading has the disadvantage of uneven penetration of rain. Rainwater in these houses commonly drains to varying points on the root builds up at those points and then produces a stream of running water which washes out the pots below. This undesirable effect is also common with cheaper brands of synthetic cloth. A major disadvantage of hessian is that it will rot.

The other main alternative material is slatting made from timber, plastic or metal strips. These will not rot or wash out the pots underneath

but lack the flexibility of being able to be rolled on or off.

When building a shadehouse, be careful about the degree of shade you are creating. The light requirements of some plants are specific and this should be investigated before construction.

PROPAGATING MATERIALS

CONTAINERS

Most Plants are grown and sold in containers. The exceptions are listed below:

- **bulbs** which are sold bare of soil in their dormant season.
- **deciduous ornamental and fruit trees** which are usually grown in the open wound and dug up bare-rooted in the winter when they are dormant. They are stored at this time in bundles with the roots covered by earth, straw or sawdust to prevent drying out.
- **herbaceous perennials and herbs** grown in the open ground, which are usually dug up in the cooler parts of the year and sold as they are with a ball of soil around the roots, or else potted for sale
- **citrus trees** which are usually propagated in the open ground but can be dug and either wrapped in a ball of hessian or planted into a container for sale during the winter.
- **conifers, rhododendrons. camellias. azaleas and some other exotic trees and shrubs**, which are sometimes grown in the open ground and treated similarly to citrus in preparation for sale.
- **berry fruit** is usually treated similarly to either the deciduous fruit trees or the herbaceous perennials as described above.
- **some other deciduous plants** (e.g. lilac, grapes, weigelia, deciduous viburnum etc.) are often grown similarly to deciduous fruit trees.

There is a wide variety of different containers on the market today for nursery use.

Standard Plastic Pots

Of all containers. these come in the largest variety of shapes and sizes and are by far the most widely used. Occasionally a plastic pot will be produced which has insufficient drainage holes, but apart from this odd occurence, little can be said against this type of container. They are clean, not too heavy, able to be obtained in a shape to suit most types of plants and are reusable. Some environment-conscious nurseries have found it worth their while to place a deposit on pots.

Believe it or not, customers do return the pots!

Flower and vegetable seedlings are usually grown in the standard sized plastic punnets. Propagation nurseries use 50 mm (2 in) diameter pots (tubes) for growing seedlings and cuttings prior to sale. Indoor plants are usually sold out of anything from a 100 mm (4 in) to a 150 mm (6 in) diameter pot .

Shrubs and trees are usually sold from a 125 mm (5in), 150 mm (6 in) or a 9 litre (2 gallon) bucket-sized pot. Herbs are most frequently sold in approximately 85 mm square pots.

Clay Pots

The main advantage of these is that they are porous and will drain through the sides as well as the hole in the bottom. In situations where very good drainage is essential, this is a great advantage, but in many cases it can lead to excessive drying out. Clay pots are heavy and therefore make more work. They can, after repeated use, build up toxic levels of salt and the plants grown in them do have a greater tendency to become potbound.

Peat Pots

These are small pots, approximately 80 mm in size, pressed into shape from peat. These have the advantage that they can be planted straight into the soil or the next-sized pot without removing the plant from the peat pot. They are reusable.

Growool

Also known as rockwool, these are blocks of insulation-like material manufactured by Bradford Insulation, which are used for striking cuttings. Growool is becoming very popular in the industry and is well worth considering.

Ceramic pots are expensive, but can greatly enhance the chances of selling a plant, particularly as a gift item.

Because they are cheap, durable, and available in many sizes, plastic pots have dominated the nursery scene for many years now.

Metal Containers

For many years, recycled jam tins were used widely but now, mainly because of market demands, they are very rarely used. Many retail nurseries refuse to buy plants grown in tins. Other types of metal containers (usually aluminium) are used occasionally.

Polythene Bags

In the early 1970s, several nurseries in Australia began using polythene bags but mainly because they were difficult to carry; harder to pot into and more likely to tip over, most nurseries have now rejected bags. The principal advantage of bags is that they are much cheaper than many of the alternatives.

Wood Veneer Tubes

These are widely used as an alternative to the 50 mm plastic tube, particularly popular in government nurseries. They consist of a roll of wood veneer secured by a rubber band.

POTTING MIXTURES

A potting soil needs to provide the plant with the following:

- sufficient nutrients for it to grow
- sufficient (but not too much) water
- adequate aeration (plant roots need air as well as water)
- proper support so that it will stand up and be held firm
- a clean, disease-free environment

Potting soils are normally a combination of several different components, each by way of its own characteristics modifying the mix to bring it closer to the ideal.

The main concern, when considering components for a potting mix, is the water-holding characteristics of the alternatives. If one component holds water very well, then a component which drains freely is added to create balance. Most potting soils are mixes of these two types of materials, e.g. coarse sand for drainage mixed with lignite, peat or vermiculite to hold water, or sandy loam for drainage mixed with mountain soil to hold moisture.

Several recommended mixes have been set down over the years but because of the continually changing supply of components and for that matter, the changing nature of components (i.e. mountain soil from one supplier can be a rich loam whereas from another it can be almost clay), the successful nurseryman continually needs to watch, modify and sometimes change his soil mixes. It should be noted that the ideal potting mix varies considerably according to the plant being grown. If a nursery specialises in one type of plant it should be able to use one single soil mix, but if a wide variety of different types of plants are grown, three or four different mixes might be required.

A clean, disease-free soil (sterile soil) is an accepted necessity in the modern nursery industry. This is achieved in one of two ways: either by using soil-less components or by sterilising the soil mix once it is made up. Soil-less components include peat, lignite, coarse washed sand, scoria, vermiculite, perlite and pine bark. All of these are either manmade or else come from parts of the earth where disease organisms and weed seeds are not to be found. This means the nurseryman is far less likely to loose plants through disease and less likely to be overtaken by weeds in the containers. If any soil is used in a mix. it is essential that it be sterilised.

Proprietary potting mixes are convenient but their quality can vary from batch to batch. To avoid this problem most nurseries have mixes made up to their requirements at a sand/soils screening yard. Mixing your own is only practicable for small batches.

Soil is most effectively sterilised in a steam sterilisation unit These can be purchased but they represent an extremely large initial capital outlay.

Another simple low-cost method of sterilising small quantities of soil is to heat it in an oven. The temperature should not exceed 170°F to avoid soil nutrients breaking down. However, the soil should be heated above 140°F to make sure it is properly sterilised.

A final factor which needs to be controlled in any soil mix is the pH (i.e. level of acidity or alkalinity). This is important because some plants will grow successfully only in a certain pH range, and at some pH levels, certain plant nutrients are simply unable to be taken up by the plant.

In general, keep the soil mix at between pH 6.0 and 6.5. It is possible for the nurseryman to purchase relatively cheaply, simple chemical test kits or electric pH meters to monitor soil pH. By adding lime to a soil, pH can easily be raised, whereas adding organic matter or manure will usually lower pH. The pH is more likely to need raising than lowering.

The materials listed below are the main alternative components used in mixing potting soils.

Soils

There is a great variation in the characteristics of soils. Often a nursery will set up in a particular location because of the soil which is readily and cheaply available there. This soil will then form the basis of all soil mixes, other components being imported and added to it to create a mix more in line with what is required. Many Australian soils are naturally low in phosphorus and thus require the addition of phosphate if non-Australian plants (which are unused to this condition) are to be grown. Be careful of variation in the characteristics of any soil you are using and be particularly careful of importing disease with your imported soil.

Sand

The normal sand used in nursery work is a very coarse granitic sand, the same type as is used in fish aquaria. Be sure that your sand is free of any salt or excessive fine particles. It should always be a washed sand. In large quantities, sand has the disadvantage of increasing the weight of the mix. Nevertheless sand of the type described is very widely used in both propagating and potting mixes.

Peat Moss

Because of increased costs in recent years, this once almost indispensable component of soil mixes has been largely substituted with such things as pine bark and vermiculite which are cheaper materials having very similar physical properties. The physical properties which are so desirable in all these materials are their ability to hold moisture while not becoming waterlogged, their ability to bind other soil components together while not setting into a hard lump, and their ability to hold nutrients, stopping them from being washed through the pot before they can be used. Peat is light in weight but has a low pH (4.0 - 4.5) which makes it necessary for mixes using peat to be treated with lime.

Pine Bark

Only a fine grade (6 mm or less~ should be used in potting soils. There are two main problems with this material:

- Toxicity: fresh pine bark contains compounds toxic to plants, especially young seedlings. The bark should be kept in a moist heap for six to eight weeks before using. Never use if a resinous smell still exists.
- Nitrogen Fixation: as the bark is slowly decomposed by bacteria Nitrogen from the potting mix is used by those same bacteria. It is necessaryto add additional fertiliser to plants grown in mixes containing pine particularly in the first few months.

Pine bark is a useful ingredient for potting mixes but it tends to use up available nitrogen; in addition it must be used in a fine grade only and cannot be used fresh because of toxicity.

Scoria is a useful ‘soil-less’ potting material: it consists of porous volcanic particles having good physical properties but sometimes variable acidity.

Vermiculite

This is made by heating and thus expanding a type of mica. It can perhaps be described as porous sponge-like particles no more than a few millimetres across. It is very light in weight and has a great ability to absorb water. Never use more than 40 per cent vermiculite in a mix. If you do, its structure will collapse after about twelve months.

Perlite

This consists of lightweight off-white balls which are of volcanic origin. Perlite has much the same qualities as vermiculite except it has a much lesser ability to hold water. Though it will hold up to four times its own weight in water, it can be used in mixes to improve the drainage significantly.

Compost

Though variable in its qualities, a good compost can be used as a substitute for peat or pine bark.

Scoria

In grade of 6mm or less, this can be used successfully as a soil or sand substitute.The physical properties of scoria are good but a variable pH poses some problems at times.

Sawdust

Sawdust and woodshavings have been used in potting mixes as a peat substitute. They are excellent in their physical properties but have the same toxin and nitrogen-fixation problems as pine bark. Sawdust should be limed and kept moist for a couple of months before using. Use 3 kg of ground limestone per m3.

Lignite

Sold In Victoria as Ligna Peat, this by-product of coal mines is a good substitute for soil or peat. It has a greater water-holding capacity than peat and should be used in lesser proportions than peat to achieve the same effect. It is best used in proportions not greater than 20 per cent.

Recommended Mixes

The mixes listed below are meant as a guide; they are not black and white recipes. There are other mixes which will bejust as good, if not better, for your sItuation. It is best to design your own soil mix to suit what you are growing, where you are growing it and what components are most readily and economically available in your area.

For Propagation of Seed and Cuttings

Mix 'A'	75% coarse granite sand
	25% peat moss (or vermiculite)
Mix 'B'	85% coarse granitic sand
	15% lignite

For Potting Rooted Cuttings or Seedlings

Soil Mix:	40% coarse granitic sand
	30% loam soil
	30% peat (or vermiculite, lignite or compost)
Soil-less Mix:	50-60% coarse granitic sand
	10-20% perlite
	15% lignite
	15% vermiculite (or pine bark)

For Potting into 10-cm or Larger Containers

Soil Mix:	25% coarse granitic sand
	50% loam soil
	25% peat (or vermiculite, lignite or compost)
Soil-less Mix:	30% coarse granitic sand
	20% scoria
	25% lignite
	25% pine bark

Handwritten stick-in labels are convenient, though occasionally they are replaced in the wrong pot! Both botanical and common names should be shown.

Printed labels cost more, but they save time spent on writing labels by hand. They can carry a great deal of information and unquestionably increase the chances of selling a plant.

LABELS

Every plant which is to be sold should have its own label. These can be handwritten or printed but remember to be accurate. If uncertain, don't label until you are certain. Printed plastic or card labels can be purchased. There is no doubt that the more elaborate labels with a photograph do help sell the plant but they are also expensive. Blank plastic or card labels are much cheaper but have to be written on, Stick-in labels sometimes present a problem with people removing them and even replacing them in the wrong pots, Tie-on labels do not move this way, but can ringbark a young plant if left on too long.

Printed labels bearing a photograph are probably the most effective type of all.

In addition to labels on individual sale plants, 'display / information' labels are used; a single label is placed on a group of plants or an individual plant in a more prominent display section or a display garden. This label aims to interest inform and sell. Display gardens with labelled plants are becoming more common in all types of nurseries but particularly native plant and herb nurseries. It is standard practice in most nurseries to place plants which are in flower in a prominent position near the entrance. Clearly labelled (including the price), these plants have a very good chance of selling. Plants which are to be sold should be grouped and ideally laid out in rows, in alphabetical order, and clearly labelled.

These display/information labels should be both more prominent and more informative than labels on individual plants which are to be sold. Be accurate with your labelling - too many nurseries don't realise the serious implications of inaccurate labelling. Remember, plants grow differently in different parts of Australia, even different parts of the same city. These labels should include height width, flower colour, hardiness and price as well as both the scientific and common names of the plant.

PLANT HEALTH PROBLEMS

Health problems are most likely to occur in young plants. The nurseryman or herb grower needs to know three things:

- how to treat plants in order to minimise the likelihood of health problems occurring in the first place
- if a problem does occur, how to recognise and identify it
- how to treat a problem

DIAGNOSING PROBLEMS

Diagnosing a problem involves being aware of the possibilities and systematically eliminating what the problem is not until you are left with only one possibility. It is usually fairly easy to get down to a short list of two or three possibilities. If you are stumped at this point you can either seek professional advice or, one at a time, treat each of the possibilities on the short list until something works.

Parasite and Pest Damage

FUNGI. 'Damping off' is a term referring to a broad group of fungal diseases which are common on young plants, particularly seedlings. Damping off is indicated by the plant rotting usually on the stem at a point where it joins the roots, causing the top to collapse as the base disintegrates. Mildews, moulds and rots are all types of fungi.

BACTERIA can cause galls, rots, etc., but these are fairly uncommon in most nursery or herb farm situations.

VIRUS. Viral problems are usually easily identified; they show as one or a combination of the following symptoms:

- malformation or distortion of growth
- variegation or discoloration of leaves
- reduced vigour
- galls (swellings) on the roots

INSECT DAMAGE is usually relatively obvious; if you look hard enough you can actually see them. Always check behind the leaves and use a magnifying glass; some insects are very small!

OTHER SMALL ANIMALS. Arthropods such as red spider or millipedes can be seen if you look hard enough around the plants. Snails and slugs can be seen, if not directly, by the slimy trail they leave.

LARGER ANIMALS. Rabbits and possums usually damage plants in a manner which makes it obvious that something large has been involved. Their bite marks are distinctly bigger than those of a caterpillar!

PARASITIC PLANTS AND WEEDS. Although their presence is obvious, their influence once is often overlooked.

Environmental and Nutritional Problems

A wide range of environmental factors can damage or restrict the growth of plants, e.g. frost, wind, low temperature, high temperature, unfavourable light, poor soil structure, too much or too little water and atmospheric impurities.

For good growth, plants require a wide range of different nutrients. Nutrients are divided into major and minor nutrients.

MAJOR NUTRIENTS are required in large quantities by all plants and for that reason are more likely to become depleted particularly in a situation where plants are grown in the open ground using the same ground over and over again. The five major nutrients are nitrogen, potassium, phosphorus, calcium and magnesium. Nitrogen, phosphorus and potassium are applied more often because magnesium and calcium tend to occur in most soils in naturally large quantities.

MINOR NUTRIENTS are required by the plant only in very small amounts, but are nevertheless vital to the plant's growth. Scientists do not agree completely on the elements which should be considered on this list but important minor elements are iron, zinc, manganese, copper, molybdenum, boron, chlorine, cobalt and silicon.

Some of the more likely nutrient deficiencies are described below.

NITROGEN DEFICIENCY shows as yellowing between the veins on the older leaves. This can be induced by excessive soil moisture, in which case the remedy is drying out or improving drainage. If this is not the case, however nitrogen deficient plants should be fed with a liquid nitrogen fertiliser. This can be made by soaking manure in water for six months (be careful it is not too strong though). Alternatively, use a product such as Phostrogen, Aquasol or Thrive.

POTASSIUM DEFICIENCY shows as a yellowing and later burning at the tips of the leaves, gradually spreading along the edges towards the leaf stalk.

It can be cured by feeding with potassium nitrate or wood ash.

IRON DEFICIENCY shows as a yellowing between the veins on the young leaves or equally on all the leaves. This is relatively common with Proteaceae plants (e.g. grevilleas, banksias, proteas and hakeas), citrus, camellias and azaleas. Sprinkle scrapings of iron rust around the base of the plant to remedy.

General Diagnostic Hints

Whenever examining a sick plant a number of factors need to be considered:

- is there more than one problem involved? Often if a plant is weak because of some non-parasitic problem, it becomes susceptible to attack by a parasite.
- is the damage or sickness general or isolated to one particular part of the plant? If a plant is burnt on the exposed parts only, then it is likely that the burn is caused by some environmental factor.
- consider any dramatic changes which have occurred in recent times in the plant's immediate or more general environment. Has it been a dry, hot, wet or cold season? Has some protective fence been erected or moved in the vicinity of the plant? Was there a wind storm or bad frost recently?

MINIMISING THE LIKELIHOOD OF PROBLEMS

The UC System

Work carried out in the early 1950s at the University of California has led to a complete revolution in the approach to disease control in the nursery industry throughout the entire world. The UC System, as this work has come to be known is based on stringent preventative measures. At first impressions a UC System nursery might appear to be practising cleanliness on a level not much different from a hospital and this observation is, in many ways, not far wrong. Every effort needs to be made to ensure that disease organisms never get past the front gate of the nursery.

The major practices of the UC System are summarised below.

Use a good clean soil mix. either sterilised or from clean soil-less components. Soil should be physically and chemically uniform. It should provide good aeration and drainage but also have the ability to hold enough nutrients and water.

Nutrition levels should be maintained in soil by frequent light feeding rather than occasional heavy feeding.

Use only clean (disease-free) seed, cuttings and other propagating material.

Sterilise all pots, tools, nursery benches etc. before use. This can be done with a disinfectant solution such as Dettol or formalin. Some disinfectants have fumes toxic to plants, so beware. Clean and dirty pots should be kept apart.

Remove and burn diseased plants as soon as they are detected.

Segregate propagation areas from the rest of the nursery and allow no-one but those necessary into them. Have a shallow tray with disinfectant solution at the entrance to propagating areas. When entering, workers should step in the solution to eliminate any disease on their boots.

Workers should always wash their hands before commencing work, particularly when propagating.

Avoid splashing water around. This can wash disease from one place to another.

Hang hose nozzles on hooks, do not let them lie on the floor or the ground.

Do not under-rate the importance of these practices.

Companion Planting

This is the other method of minimising the likelihood of disease.

Companion planting is based on the notion that certain plants are of benefit to other plants when planted nearby. Companion plants work in two ways.

Some repel or kill the disease or problem usually by way of the chemical nature of something in their leaves, stem or roots. Many of these types of plants need regular brushing to release the essential oils in the foliage if they are to work. If this is the case, they are best planted beside a path where they will constantly be knocked broken and brushed (e.g. Lad's love repels aphis if brushed regularly). Other companion plants do not need this constant brushing (e.g. garlic planted under peach trees will reduce the likelihood of peach leaf curl. Garlic has a natural fungicide in the roots which, when absorbed into the peach, deters the leaf curl fungus). Other companion plants attract the problem away from your preferred plant. The classic example of this Is nasturtium planted near vegetables. The nasturtium attracts aphis onto itself.

Total control of pest and disease is very unlikely to be achieved by using companion plants alone. Their benefit is that they can reduce the likelihood and quantity of problems to an acceptable level.

Companion planting can be effective in several ways: certain plants may repel pests, others may attract them (away from preferred plants), and some plants simply seem to thrive in proximity to certain others.

Most of the plants in the Labiatae family (mints) have a repellent effect on insects if the essential oils are released from their foliage. The release of the oils is of prime importance; without it these plants are attacked by the very insects their oils repel. Labiatae plants comprise all of the mints including native mint bush (prostanthera), thyme, rosemary, balm, sage, oregano and marjoram.

Those herb and vegetable plants related to onion (e.g. chives, shallots and garlic) contain a natural fungicide which helps deter fungal problems.

To be effective, they must be planted at the roots of the plants to be protected. Onions can also be used as a bait for aphis.

TREATING A PROBLEM

Nutritional Deficiencies

These are corrected simply by adding the nutrient which is deficient. In extreme cases, it is important to get the required nutrient into the plant and working very quickly. Often this can be done only by using artificial fertilisers.

The classic sign of iron deficiency - yellowing of the younger, upper leaves. (Nitrogen deficiency shows as yellowing of the older, lower leaves.)

Nutrient Toxicities

These usually show as a burning of the foliage. They can be corrected only by leaching the excess chemical away from the roots through heavy watering.

Environmental Problems

These are usually not detected until after the damage is done. At this stage all that can be done is to protect the plant from a recurrence of the problem.

Fungal Problems

Sometimes the plants can be given a chance by reducing the moisture, allowing them to dry out. Garlic spray is a natural fungicide which is relatively effective. In the case of damping off disease in young plants though, it is usually a straight choice between using a chemical such as Benlate or Le San DX or else losing the plants. These chemicals are relatively harmless to man and the environment.

Insect Problems

Praying mantis and other predatory insects are a form of natural pest control, but one which is incompatible with spraying.

The ladybird has been a gardener's friend for many centuries because of its fondness for aphis.

Pyrethrum is extracted from a chrysanthemum grown in New Guinea, but an effective substitute can be made by boiling the leaves of feverfew (shown above).

The most common method of controlling insects is the use of chemical sprays. These vary greatly in both their effect on insects and their effect on man and the environment. **Under no circumstances should you ever use Dieldrin or Aldrin.** These chemicals, apart from being very poisonous, remain in an active form in the environment for hundreds of years.

Pyrethrum is a natural insecticide extracted from a type of chrysanthemum. This chemical is effective on most insects provided it is sprayed thoroughly. White oil is another relatively harmless insecticide, used principally for controlling scale. It works by simply covering the insect with a layer of oil and thus suffocating it. Obviously, white oil must be sprayed thoroughly if it is to work.

An alternative to insecticides is to encourage natural control. Birds, praying mantis, ladybirds, spiders etc. will have a natural controlling influence on insect pests. Unfortunately, when you spray insects you also harm these beneficial animals. It is not advisable to mix the two methods. You should either opt for chemicals or for natural control.

Chemicals can give you a more effective control but their use is time consuming, expensive and potentially dangerous.

Weed Problems

Perhaps the most important aspect of weed control is never to let them produce seed. One weed can be a problem but when it produces thousands of seeds, that problem is multiplied enormously.

In the open ground, weeds are easily controlled by either cultivation (plan the spacing of your rows of plants to fit the width of your rotary hoe) or by mulching or even mowing. In pots, mulching the top of the pot with coarse sand or wood shavings can help reduce the weed problem.

Snails and Slugs

Stale beer can be used very effectively to control snails and slugs. Cut an opening in the neck of a bottle large enough for these pests to enter. Place the beer in the bottle and bury it on its side so the entrance is level with the ground.

General

A plant is more likely to contract disease when it is already weak through some other problem. Keep your plants well watered and fed, eliminate problems immediately they arise and your total number of plant problems will be far less.

SEED PROPOGATION

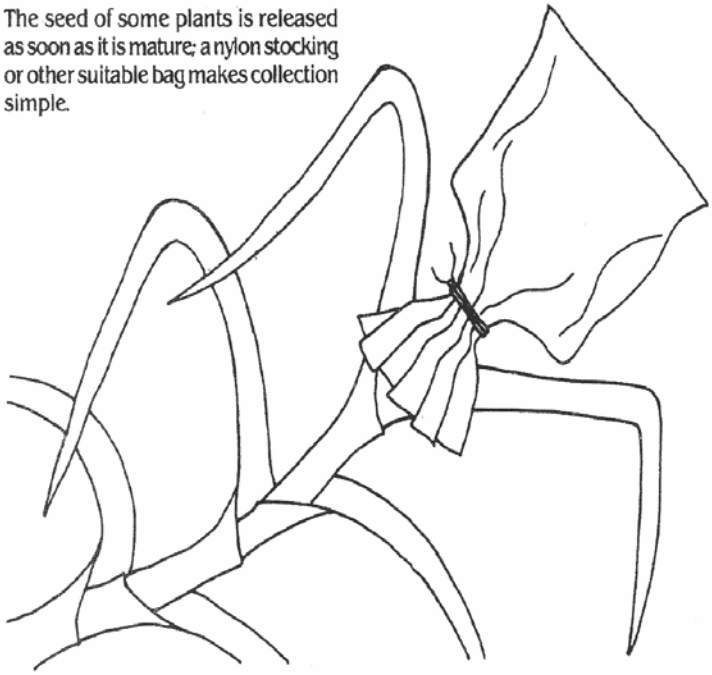
Although an understanding of the structure and development of a seed is valuable to developing a theoretical understanding of seed propagation, this chapter will largely avoid these areas, giving preference to matters of basic practical concern. These areas can be read up, if you wish. in any standard botany textbook.

You should be very aware of the following points:

- seed-grown plants are often different from their parents
- not all plants are grown easily from seed
- often seed must experience a certain set of environmental conditions before it will germinate
- seed and very young seedlings are more susceptible to disease attack or adverse environments than any other type of plant
- seeds have their own store of food to support the new plant in its early stages of life; they don't need fertiliser
- some seeds will store easily while others need very special conditions for storage
- some seeds can be stored viable for many years while others will die if not not germinated immediately they are harvested
- seed varies in size from a fine dust to nuts as large as a football
- shape and colour of seed is as variable as size
- some seed can be difficult to remove from the fruit encompassing it
- the germination process can vary in time from a few days to several years, although for most plants it is between one and four weeks.

Collecting and Handling Seed

It is essential that seed be of good quality and from a reliable source. Seed merchants tend to specialise in either annual and vegetable seeds or else tree and shrub seed.



The seed of some plants is released as soon as it is mature; a nylon stocking or other suitable bag makes collection simple.

Very few reliable suppliers sell both. It is strongly advised that you shop around and purchase seed only after receiving recommendations from a couple of the supplier's customers.

It is sometimes worthwhile growing your own seed but usually only with plants which do not have any complications involved in their seed production. Similarly it is sometimes worthwhile collecting seed from established plants in public gardens, bush areas etc. (For this you may require permission from the appropriate authorities.)

Problems may arise when growing plants from collected seed. These difficulties usually arise through desiccation, disease or cross-pollination.

Cross-Pollination

Many plants will naturally cross-pollinate with other varieties or even species. Their progeny then contain half the characteristics of the parent plant and half from the wild variety. This problem can be avoided only by growing or selecting seed from plants which are isolated from specimens of closely related plants. Eucalypt seed for example, is best selected from trees which are in a forest of only the one species of eucalypt. Take the seed from trees in the centre, not on the edge of such a forest. If you wish to grow one type of thyme for seed, grow it in a part of the garden as far as possible away from other varieties of thyme.

Disease

Many of the legume (pea) plants can have their seed eaten by grubs. For such families as sarsaparilla, kennedya and acacia you should watch the development of seed pods carefully, removing and burning those attacked as soon as detected.

Lettuce seed is produced in Swan Hill because of its isolation from a virus disease which is carried by the seed to affect new plants.

Desiccation

Upon reaching maturity, seeds of some plants are immediately released from the fruit. For such plants, the seed collector must watch closely in order to catch the seed before it is lost. As the seeds near maturity, a nylon stocking can be tied over the fruits so that the seeds are released into the stocking when they drop. Other types of bags can be used, but they must be able to 'breathe'. Do not leave the dropped seed for too long in the stocking as it may begin to germinate. Usually seeds which fall into this category are those which have a shorter life - annuals, herbaceous perennials and short-lived woody plants such as the legumes.

Some plants will not drop their seed at all until the right set of environmental conditions have been met. Most of the Australian myrtaceae plants fall into this group (e.g. eucalyptus, callistemon, melaleuca and leptospermum). To obtain the seed from the Myrtaceae plants, harvest the nuts, place the nuts on a metal tray and put into the oven at a temperature of no higher than 140°F (60°C). The nuts should be checked every ten minutes until they open and release the seed. (NB: this same method is used with banksia and hakea seed; usually, seed from older nuts will germinate better.)

Time to Collect Seed

Seed which is held on the plant for years, such as banksia or melaleuca can be collected at any time of the year. Seed which is released immediately is obviously collected at whatever time it ripens.

Seed from most deciduous plants ripens during the autumn. In the main, it will stay on the plant for anything up to a couple of months following ripening. It can be harvested any time over this period.

Seed from soft fruit (e.g. apples and peaches) or berries (e.g. cotoneaster or crataegus) is ripe when the fruit or berry changes colour (from green to red or yellow in most cases).

Storing Seed

Different seeds will keep for different periods of time depending on both the type of plant and the way in which the seed is stored. There are many ways of storing seed.

OPEN STORE describes seed stored in bins, sacks or some other type of container in a dry place, but without any artificial control of temperature or moisture. Seed is exposed to the air.

DRY STORE involves keeping seed free of moisture; it is first dried and then placed in either a moisture controlled room or alternatively, sealed containers or packets.

COLD STORE - the keeping quality of virtually any seed will be increased by storing at a temperature between 1°C and 10°e. The temperature should not be below freezing. This storage can take place in the normal compartment of any refrigerator.

COLD MOIST STORE describes keeping the seed at a temperature between O°C and 10°C while maintaining the moisture content of the seed (i.e. they should not dry out). This is done by placing in a sealed container which will maintain a certain moisture level.

Seeds Which Can Be Open Stored

Acacia
Albizzia
Callistemon
Elaeagnus
Eucalyptus
Grass seed
Grevillea
Kennedya
Koelreuteria
Melaleuca
Most herb seed
Most vegetable seed
Rhus
Robinia
Tilia (linden)

Seeds Which Are Better Dry Stored

Most annual flower seed
Most herbs
Most herbaceous perennials
Most vegetable seed

Seeds Which Should Be Cold Stored

Abies (fir)
Acer (maple)
Arbutus (Irish strawberry)
Berberis
Cercis
Cupressus
Fraxinus (ash)
Gleditsia
Malus (apple)
Most Conifers
Most deciduous trees
Picea (spruce)
Platanus (sycamore)
Prunus
Rubus (bramble fruit)
Sambacus
Sorbus
Symphoricarpos
Vitex
Vitis (grape)

Seeds Which Are Best Cold, Moist Stored

Acer
Carya (hickory)
Castanea (chestnut)
Citrus
Corylus (filbert)
Fagus (beech)
Juglans (walnut)
Quercus (oak)

Approximate Viability for Various Plants

The plants listed below are grouped according to the length of time their seeds are likely to remain alive and viable. You should note that the viability of a batch of seeds will diminish gradually over a period of years.

Usually viability drops at a slow rate at first but after a certain period of time it diminishes quickly, leaving all the seed dead within the space of anything from a couple of weeks to a couple of years. The lists below refers to the time at which this rapid decline in viability begins.

I year: sweet corn, onion, parsley, parsnip, delphinium, kochia, acer (some species), alnus, aralia, pawpaw, cedar, cryptomeria, liquidambar, magnolia, mahonia, nandina, persimmon, poplar, rhus, sophora, willow, ulmus (elm).

2 years:	most conifers, beet, capsicum, helichrysum, aster
3 years:	phlox, verbena, asparagus, bean, celery, carrot lettuce, pea, spinach, tomato
4 years:	cabbage, cauliflower, eggplant, okra, pumpkin, radish, turnip, squash, iberis
5 years:	cucumber, endive, watermelon, alyssum, calendula, chrysanthemum, cosmos, dianthus, poppy, sweet pea, stock, petunia, marigold, nasturtium, pansy, zinnia
More than 10 years:	acacia, albizzia, elaeagnus, eucalyptus, melaleuca, callistemon, leptospermum, kennedya, rhus, robinia, tilia

Every nursery raising plants from seed needs a variety of growing environments - open ground, cold frame, glasshouse, and shadehouse.

WHERE TO PLANT

Usually seeds are planted in one of three possible situations.

IN A CONTAINER which is placed under glass (i.e. in a glasshouse or cold frame). Seed sown this way is usually in a very well drained medium (e.g. 75 per cent coarse sand and 25 per cent vermiculite or peat moss).

If sown in a cold frame, seedlings are normally planted in a mix having excellent drainage properties.

IN AN OPEN BED there is little or no protection from the natural environment The ground is prepared by cultivating with either a plough or rotary hoe. Often a quantity of organic manure is turned in at this stage. The cultivated ground is formed into raised beds with approximately one metre between their centres. One row of seed is planted along each of these beds. After germination any excess seedlings must be thinned out to allow proper space for growth.

IN A PROTECTED BED, the bed is built inside a cold frame or glasshouse, or some protective structure is built over an open bed. A simple example would be four logs laid on the ground over a seed bed with a PVC sheet resting on the top.

Most seed-grown plants can be started in a container under glass. Most deciduous trees, fruit trees and some conifers are sown direct into the open ground. A large degree of success can be achieved by starting some of the native Australian species in a protected outside bed as described above. Many of the perennial flowering plants can also be grown this way.

It is important that during germination, the seed be kept both moist and well drained. For the first few months after germination, it is critical that the young plant be protected from fungal diseases and insect attack.

PRE-GERMINATION TREATMENTS

Seeds can be classified on the basis of their pre-germination requirements:

- seed which will germinate in the appropriate temperature and moisture conditions without any pre-germination treatment (e.g. most vegetables, annual flowers, herbs, eucalyptus, melaleuca, callistemon, eptospermum, etc.)
- seed which has a hard seed coat that is impermeable to water; this must be cracked before the seed will germinate. The seed coat can be cracked by either treating with boiling water, burning or some form of mechanical scarification such as rubbing between two sheets of sandpaper. Scarification is difficult and can be overdone thereby damaging the seed.
- seed with a dormant embryo; this requires chilling before germination will take place
- seed with both a dormant embryo and a hard seed coat
- seed containing chemicals that inhibit germination (e.g. palms); in these cases the chemicals must be leached out before germinating, a process which can lead to spasmodic germination.
- seed which is dormant on harvesting but becomes viable after dry storage.

Hot-Water Treatment

Seeds are placed in a jar and four or five times their volume of boiling water is poured onto them. They are then left for anything up to 24 hours standing in the cooling water. Upon removal they are planted immediately by sprinkling on the surface ofthe prepared medium and covered with a thin layer of sand (sufficient to barely cover the seed). Many legumes are propagated this way including acacia, kennedya, hardenbergia, pultenaea, indigofera, albizzia and most of the 'brooms'. Usually these seeds are sown in early spring.

Some conifers respond to soaking in cold water prior to sowing (i.e. Monterey pine, Douglas fir and Coulters pine).

Burning Treatment

Seeds are laid out on the medium (in the pot) where they are to be germinated. Dry leaves are soaked in methylated spirits and then spread over the top of the seed in a thin layer just covering the seed. The leaves are then lit. Once the fire goes out the pot is watered and placed in the propagating area. In times past this treatment was always used on a number of seeds including protea hakea banksia and leucodendron.

Many propagators today believe this treatment is not necessary.

Burning stimulates the germination of a number of Australian native seeds. Newspaper, dried leaves or other materials may be used. Chemicals in the smoke are known to stimulate germination in some plants.

Stratification (Moist Chilling).

Seeds are placed in sealed polythene bags along with moist (not saturated) vermiculite. These bags are stored in the normal (not freezing) compartment of the refrigerator for between one and four months, depending on the variety. Most deciduous species, conifers and berries require this type of treatment. Seed is usually removed from the fleshy fruit of berries or soft fruits before stratification. Dry seed should be soaked in water for several hours before stratification. At the end of the stratification requirement seed may begin to germinate while in storage, so if uncertain of the stratification period required you should watch the seed carefully. Seed is usually stratified over the winter and sown late winter to early spring.

Stimulating Germination

Temperature and light controls have been used at times to stimulate better and faster germination. Some seeds will germinate only in a very small temperature range. For most seed a temperature range of between 15°C and 30°C needs to be maintained during germination.

Light exposure will stimulate germination of many of the conifers, vegetables, annual flowers and herbaceous perennial plants including herbs. If the seed is not covered with propagating medium, take care that the seed does not dry out This really needs to be carried out under a mist system.

Chemicals have also been used at times, to stimulate the germinatIon of seeds. Many freshly harvested seeds benefit from soaking in a solution of potassium nitrate (0.2 per cent). Gibberellic acid and sodium hypochlorite have also been used.

HANDLING SEEDLINGS

Watering

It is essential that the young plants are not overwatered or underwatered. Even if you have automatic controls operating, it is still advisable to check on watering daily.

Disease Control

There is nothing which will put an end to a nursery faster than disease (usually damping off) on seedlings. In most commercial nurseries, a regular spray program has been found to be essential. Though as yet not tested fully, garlic spray is an organic alternative which, if sprayed regularly every week or two, might be a viable replacement for the conventional products. A commercially produced garlic spray is available (marketed by Tahara Herb Farm, Coleraine, Vic.); alternatively, you can make your own - a recipe is given later in the book.

Thinning

If seed is planted too thickly it does not allow room for proper development of the plants. In some instances, an excessive planting will create a very humid zone at the base of the plants, a condition which is ideal for the development of damping-off diseases. In either situation, you must thin out the seedlings for propagation to be successful.

Environmental Control

In a cold frame or glasshouse, adequate ventilation and temperature control must be given. In the open, drastic changes in environmental conditions should be avoided (e.g. protect during a windstorm or from any late frosts).

Transplanting

Plants grown from seed in the open ground (not Australian natives) can usually be left for a year or two before transplanting into a container or, in the case of deciduous plants, lifted bare-rooted for sale. This lifting is usually carried out in the cooler months of the year.

Plants germinated in containers are usually transplanted at 13-50 mm in height with species which have a fibrous root system (most non-Australian plants, many of the herbs, annual and perennial flowers and vegetables), it is unimportant if the tap root is broken at this stage. In the case of plants which have a deep root system (particularly native trees and larger shrubs), it is essential that the tap root is not broken. Plants with a long tap root should be potted up into a deeper type of pot.

It is important that seedlings are not planted too thickly, because this can encourage disease, especially damping off.

Vegetables and annual seedlings are normally transplanted from the place where they were germinated into punnets with approximately thirteen to fourteen plants per punnet. These are sold as being a dozen plants to the container. In some instances, these seedlings are transplanted into the standard two-compartment seedling box. It is aimed to grow just over one hundred seedlings to the box (fifty per compartment).

Many nurseries transplant seedling trees, shrubs and indoor plants into tubes from the germinating container. Others will place the seedlings straight into the larger sized container in which the plant is to be sold.

PROPAGATING FERNS

Though some ferns can be propagated by division (e.g. maidenhair) or fronds (e.g. mother spleenwort), most are grown in quantity from spores.

The spore cases on the back of fern fronds will appear as small round dots. Usually during autumn or early winter, these spore cases begin to open, releasing the dust-like spores. If you don't wish to collect your own, fern spores can be purchased from most major tree and shrub seed merchants.

It is not difficult to collect your own fern spores. The spore cases appear as black or brown dots on the back of the fronds.

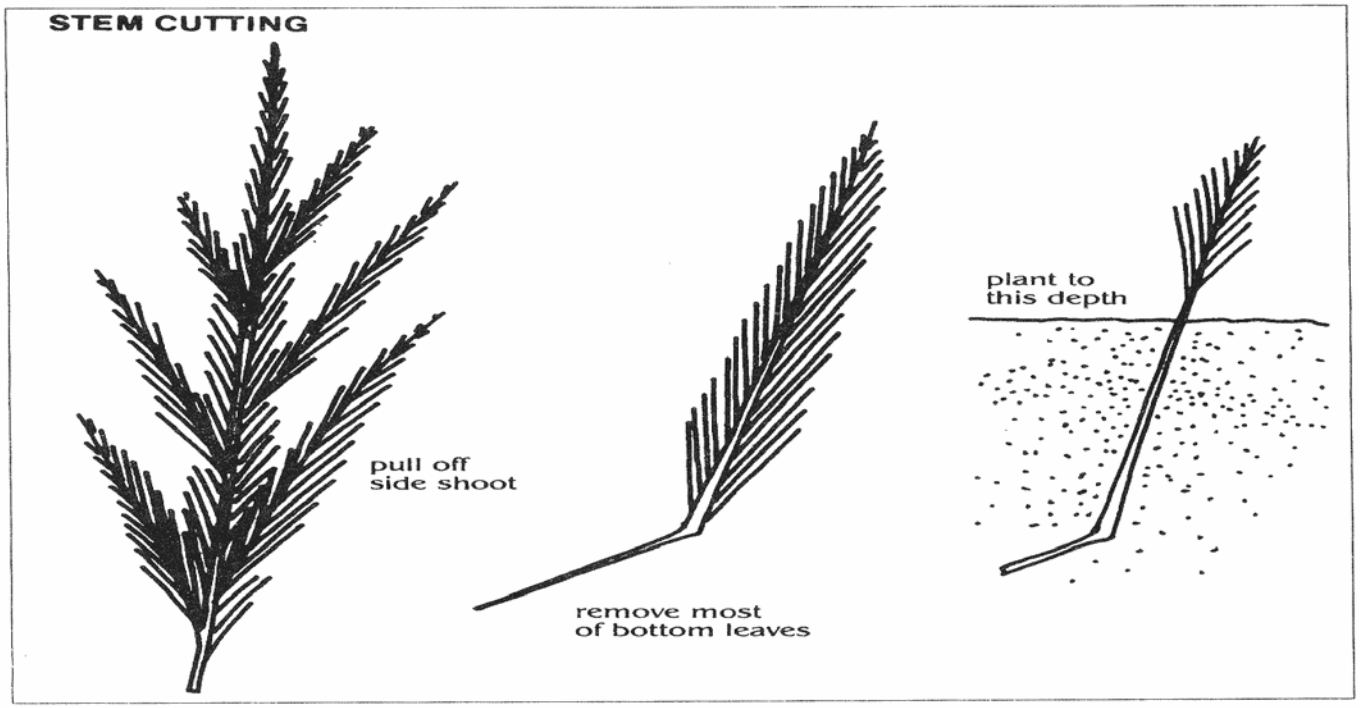
Fern spores can be sown in seedling trays, terra cotta pots or plastic pots. Adequate drainage should be ensured. The pot or tray should then be filled with a propagating medium composed of 50 per cent coarse sand and 50 per cent peat moss. It is necessary to wet the peat before mixing the medium. Sprinkle the spores on top and water with a mist sprayer. The container should then be stood in a tray of water; this will ensure it does not dry out. Place a sheet of glass or a piece of plastic held in position by a rubber band on top. This should then be placed in a shaded part of the glasshouse or a shade house. Initially, germination will appear as a green mossy growth on the surface; when this has been observed, remove the cover. Eventually small new plants will emerge.

Once fronds are a centimetre or two long. the new plants can be pricked (potted) out into small pots.

Fern spores, Vanuatu

VEGETATIVE PROPAGATION

Vegetative or asexual reproduction involves growing a new plant from a part of the vegetative growth of an existing plant. The new plant will be exactly like the parent plant in every way, from flower colour to disease susceptibility. One of the most important considerations with this type of propagation is that you have a reliable and disease-free source of vegetative material from which to propagate.



CUTTINGS

Along with seed propagation, cuttings are the most commonly used technique for multiplying plants. There are four different types of cuttings, the most common being stem. The others are leaf, root and leaf bud.

Root Development

There are three important factors in root formation:

WATER: if the cutting loses too much moisture before the roots form, it will die. For this reason, a humid atmosphere is best with a minimum amount of leaf exposed to the air and the maximum amount of moisture in the potting medium, giving due consideration to the next factor.

FUNGUS: the unrooted cutting is very susceptible to attack by fungal diseases. A very moist situation or (to a lesser extent) a warm situation will increase the likelihood of fungal attack. This problem can be minimised with the use of chemicals.

TIME: the greater the time taken for roots to form, the more likely it is that problems will be encountered with drying or fungal attack. Bottom heat will reduce the time taken for any cutting to establish. Top misting will reduce the time for root formation as well as increasing the humidity, thus reducing the likelihood of drying.

Chemical hormones are used widely to increase both the percentage of cuttings which strike as well as the rate at which they strike. The most commonly used hormones are IBA (indole butyric acid) in liquid form or Seradix (a powder form of IBA). Cuttings are dipped in these chemicals before putting in the pot. An improvement in the strike rate of up to 30 per cent is not uncommon after using these hormones.

Basal wounding is the removal of a thin strip of bark from a cutting. The area thus exposed should be slightly less than half its own length from the cutting's base. This can be beneficial on some species, e.g. Juniperus and Rhododendron.

Light is not important for hardwood cuttings, since they depend on stored carbohydrates for food but is important to the success of any leafy cuttings (ie. anything which has some leaf on it).

Sometimes cuttings form a large callus or swelling at the base without producing roots. If this happens, the callus should be nipped with a sharp knife or razor blade and replanted. Following this, roots should form from the cut

It is important with most cuttings to plant them with the same polarity they had on the plant - i.e. do not put a cutting in upside down.

Stem Cuttings

Stem cuttings are divided into four groups: hardwood, semi-hardwood, softwood and herbaceous. A stem cutting is simply a segment of shoot or stem containing several buds. They should always be prepared so that there is a bud at the bottom and the top of the cutting. Do not have any length of wood at either the bottom below the bud or at the top above the bud. Any cuts made in preparing a cutting should be with very sharp and clean secateurs on an angle to the stem.

HARDWOOD CUTTINGS are taken from a plant when the wood is hard, ie. in winter. This type of cutting is most common for propagation of deciduous woody plants, though some evergreens (notably many of the conifers) are also propagated in this way. They vary in length from 8-60 cm (3-24 in). Plants grown in this way under glass are usually about 8 cm long, but many deciduous plants which can be grown by placing cuttings straight in an open bed can commonly be 30 cm or more long. Hormones are always used on evergreen cuttings but are not so important on deciduous ones.

SEMI-HARDWOOD CUTTINGS are taken from a plant when the wood is semi-hard and when the growth is slow, usually in late summer or early autumn. Most woody broad-leaved evergreen shrubs can be grown in this way, although there are exceptions. Usually cuttings about 6 cm (2112 in) long are taken from young wood. In the past it was always recommended to take a heel (a piece of older wood at the base of the new wood) but this practice doesn't seem to have any significant value. An increasing number of nurseries are today successfully taking semi-hardwood cuttings from older wood (two or three years old). If mist is being used, remove approximately half the leaves from the cutting. If, however, the cuttings are not going to be struck under a mist system, you need to remove closer to 80 per cent of the leaves to give the best chance of success. If the cutting has only a couple of leaves, remove all but the top leaf and cut part of the top leaf off. For most plants, semi-hardwood cuttings will take about 2-3 months in a hot bed under mist before they produce sufficient roots to be potted. Without heat and mist they will take anything from 3-9 months. Cuttings can be potted straight into the containers from which they are to be sold.

After potting outdoor plants they should be kept in a shadehouse or a more protected part of the nursery before being fully exposed to sun, wind and frost.

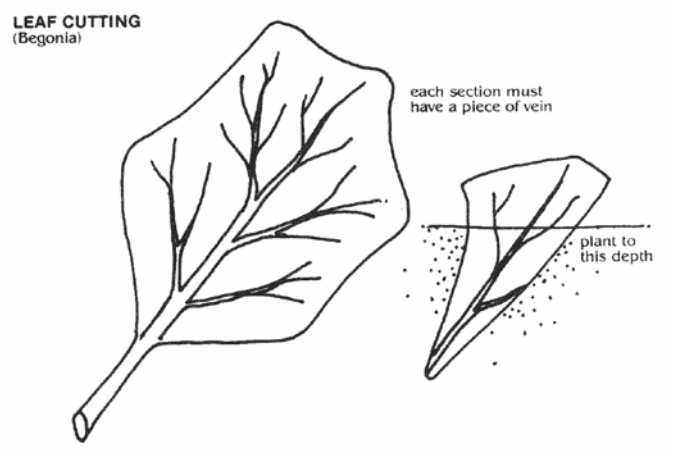
SOFTWOOD CUTTINGS are taken when the wood is soft during the rapid growth season in spring. Several non-Australian shrubs are grown very well in this way, e.g. lilac forsythia magnolia, weigelia and spirea. The type of cutting is very similar in many ways to a semi-hardwood cutting (in size, type of wood and leaves left on), only do not use wood which is too soft and growing too fast. Usually bottom heat is needed to achieve good results, but root formation is usually quicker than with semi-hardwood cuttings. Cuttings are better taken in the cooler part of the day.

HERBACEOUS CUTTINGS are leafy cuttings made using the stems of softwooded (herbaceous) plants. Plants that are able to be propagated in this way include cacti and succulents, geraniums, chrysanthemums, coleus, carnations, many of the herbs and many of the flowering perennial plants. Though bottom heat is helpful, most herbaceous cuttings will root well and easily (if a little more slowly) without it. Cuttings are usually approximately 10 cm (4 in) long with 50-70 per cent of the leaves removed. Most types of herbaceous cuttings can be successfully struck at any time of the year.

Leaf Cuttings

These consist of either a full leaf or a section of leaf with or without the leaf stalk. In the case of a leaf section, it is essential that the piece of leaf contains part of a major vein. Usually new roots and a shoot will emerge from the base of the leaf cutting, the original leaf eventually dying off.

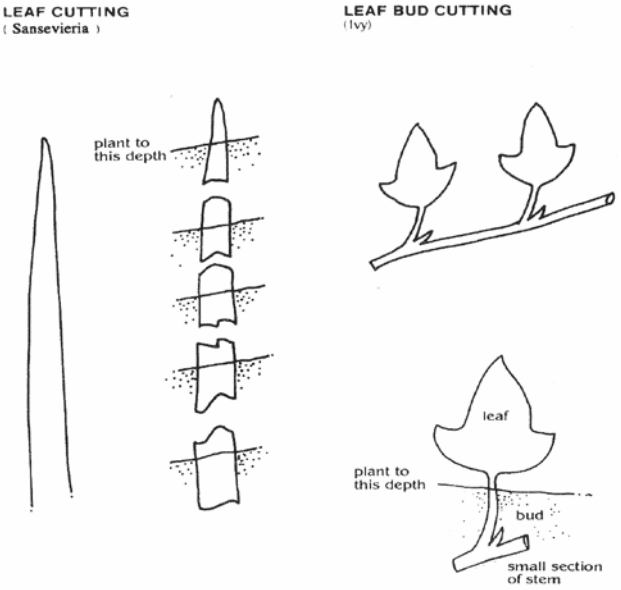
Several tropical and indoor plants can be grown in this way, e.g. begonias, African violet, gloxinia, piper, pepperomia, sansevieria and bryophyllum.



The section of leaf is planted in a pot of 75 per cent coarse sand and 25 per cent peat or vermiculite so that two-thirds of the leaf is buried. You should be aware that although sometimes the exposed part of the leaf may die, the buried part can still remain alive and give rise to new plants.

Misting and bottom heat are a distinct advantage with leaf cuttings.

Though able to be taken at any time of the year, usually better results are achieved in spring or summer. Leaf cuttings vary in the time taken until they can be potted, but even with bottom heat and misting, three months is not unreasonable.



Leaf Bud Cuttings

These consist of a single leaf with its stalk plus a small section of the stem (no more than 1.5 cm or 112 in) to which the leaf is attached. There will always be a bud at the point where the leaf joins the stem. It is from this bud that a shoot emerges to make the top of the new plant. Roots form from the cut surfaces of the stem.

Although most plants which are grown from leaf bud cuttings can be grown very successfully in other ways, this technique is often chosen because it enables a far greater quantity of new plants to be grown from the same amount of cutting material.

Plants which can be grown in this way include camellias, rhododendrons, bramble fruits, ivy, ficus and philodendron.

Root Cuttings

This type of cutting simply involves a short section of root planted in a pot of standard propagating medium so that the end of the root which was closest to the base of the plant is barely breaking the surface of the medium. Root cuttings are normally grown under glass. Obtaining the material to do this type of cutting can be difficult and for that reason, if no other, very few plants are grown by root cuttings commercially.

The following plants can be grown by root cuttings: Aralia spinosa, Chaenomeles japonica, Hydrangea quercifolia, Malus (apples), Morus (mulberry), phlox, plumbago, rhus (some species), bramble fruits, wisteria and some poplars.

Rooting Hormones

Virtually all cuttings will benefit from the application of a hormone. The most commonly used hormone is liquid IBA. This is useful because of the flexible way in which it can be applied. The concentration of IBA in water can be varied and the time the base of a cutting is immersed in the solution can be varied according to the type of plant being grown and the time of year at which it is being struck.

Plants which have a slower metabolism (e.g. conifers) are better dipped in a weaker solution for a longer period of time, whereas plants which grow rapidly are better dipped in a stronger solution for a shorter period of time.

Softwood cuttings which are growing fast should be treated either for a longer period of time or with a stronger concentration of IBA than a slower growing semi-hardwood cutting. Below are listed some recommended treatments which may serve as a guide to hormone use:

Plant	IBA Concentration (ppm)	Time of Dip
Cupressus	60	24 hrs
Metasequoia	20,000	5-10 secs
Pinus (difficult)	4000	20 secs
Abelia	500	10 secs
Cestrum	500	10 secs
Forsythia	4000	5 secs
Sansevieria	4000	5 secs
African violet	4000	5 secs
Rose	4000	5 secs
Grevillea	4000	5 secs

Quantities

It is difficult for the new nurseryman to know just how many cuttings can be taken in a day, how many can be put into one pot and what area is required for propagation. These considerations vary, but the following points may give you some guide in your nursery operations.

Between 40 and 80 stem cuttings are struck in a 12-15 cm (5-6 in) diameter pot.

Rose (hardwood) cuttings are planted in the open ground at intervals of 15 cm (6 in) with 60-90 cm (2-3 ft) between the rows.

A 2 m by 1 m (or 6 ft by 3 ft) propagation bed with heating and misting is adequate for most one-person nurseries. If specialising in cutting propagation, a larger facility may be needed.

The time from beginning propagation until sale of plants can vary greatly according to both the type of plant and the stage at which it is to be sold. Most shrubs grown from seed or cuttings can be ready for sale from a 12-15 cm diameter container within 12 months of starting. To reach the same size, conifers, camellias and rhododendrons can take 18 to 24 months. Citrus can take up to seven years to grow from the rootstock before the budded tree is saleable.

Depending on the experience of the worker and the type of plant being propagated between 1000 and 5000 cuttings can be taken in a day by one person.

It is not unreasonable to expect one person to pot up more than 1000 seedlings or rooted cuttings into 12-15 cm diameter pots in one day.

Usually when the work targets given above are not reached it is because the worker is spending time doing unnecessary tasks. One example is smoothing out the surface of the soil in pots after potting a cutting. when watering will do this.

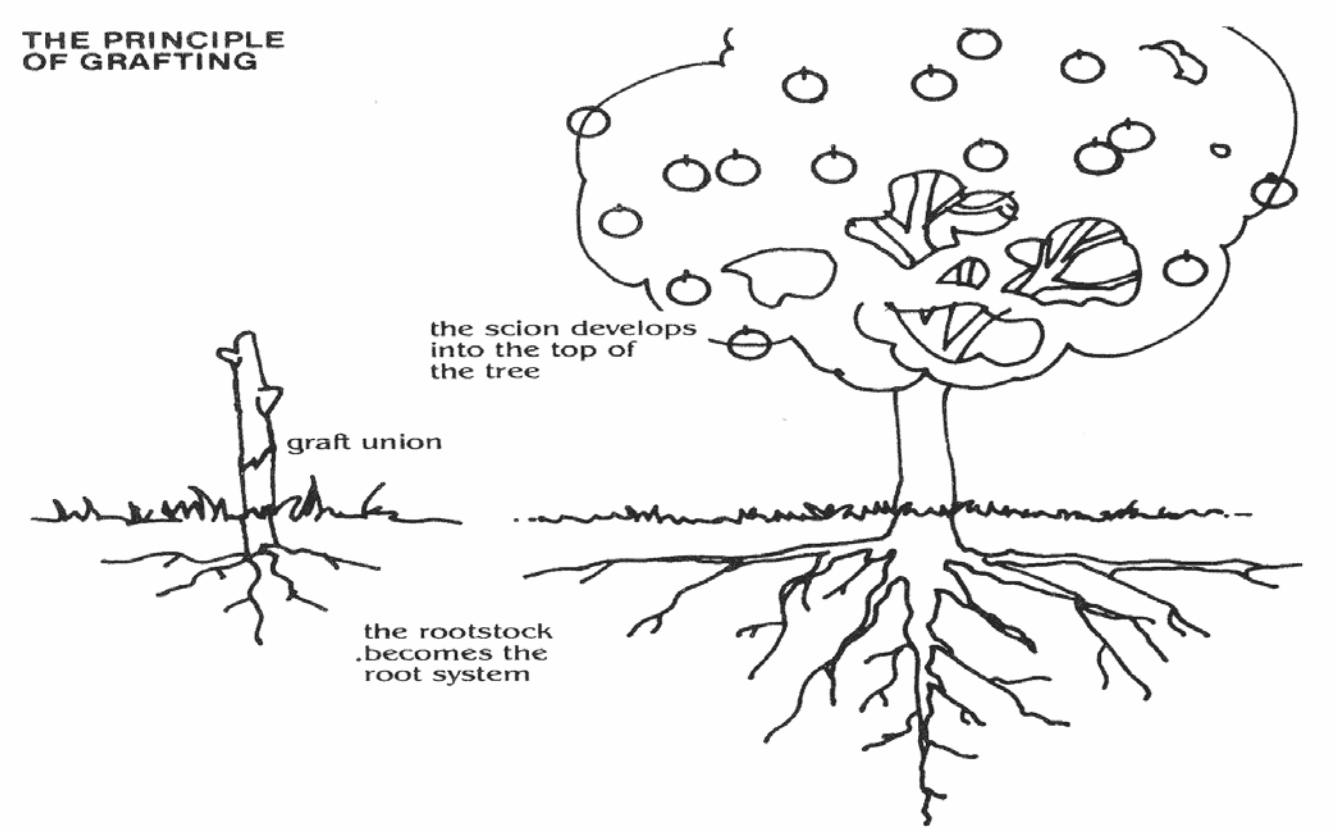
BUDDING AND GRAFTING

Budding and grafting involves joining parts of two or more different plants together in such a way that they will grow together and continue to live as one individual plant. The part which is joined onto the top is called the ‘scion’. The part which forms the root system is called the ‘rootstock’ or simply ‘stock’. If there is another part grafted between the stock and scion, this is called the ‘interstock’.

The only difference between budding and grafting is in the amount of material attached to the stock. Budding involves cutting out a single bud with a very small amount of wood backing it, then joining this to the stock. Grafting involves attaching a piece of stem containing several buds to the stock.

There are two important factors in ensuring that a bud or graft is successful.

THE CAMBIUMS MUST MATCH. The cambium or growth layer is a thin layer of cells between the bark and the inside wood of a stem. If the cambium of the bud or scion touches the cambium of the stock, then the two are able to grow together.

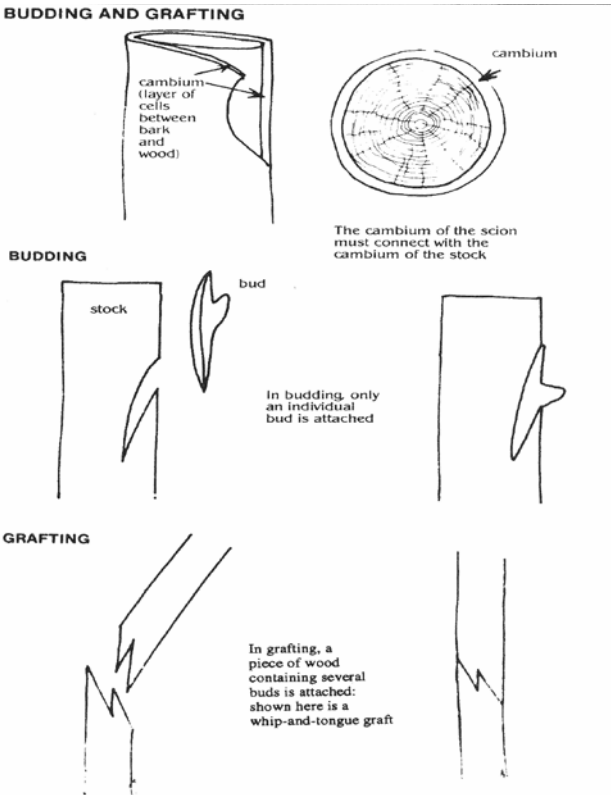


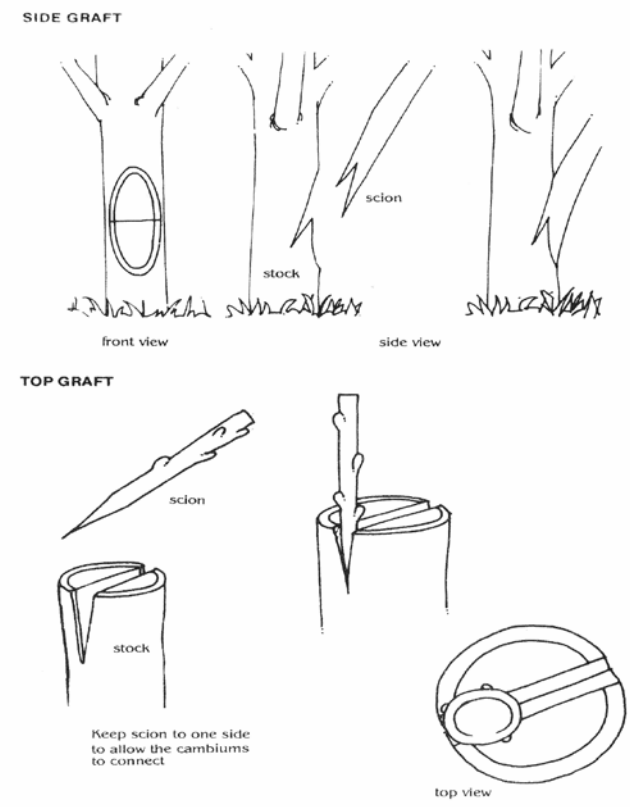
THE UNION MUST NOT DRY OUT before the bud or scion grows onto the stock. The union (point at which the two are joined) should be sealed usually with plastic tape, but alternatively with grafting mastic, a material similar to putty.

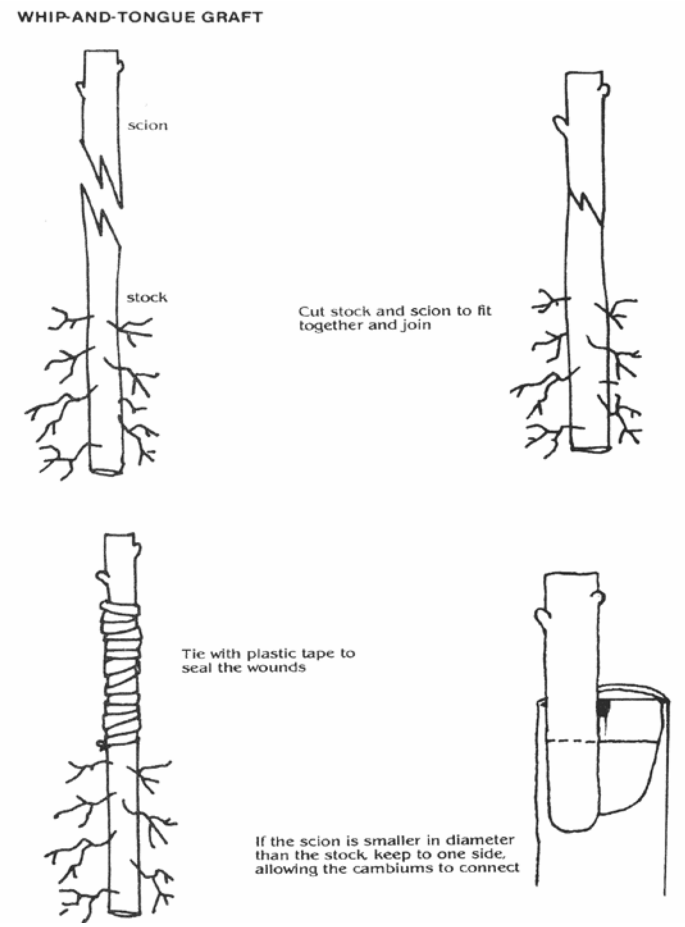
Plants are budded or grafted for a number of reasons.

TO MAINTAIN A PARTICUIAR VARIEIY OF PLANT. It is often possible to grow a species easily from seed or perhaps a less desirable variety of a species from cuttings.

The more desirable variety, however, is more difficult or perhaps slower to propagate. You are therefore easily able to grow plants which can be budded or grafted but not so easily able to start off the particular variety you want. Blue Spruce is an example: seedlings will grow well, but only a small proportion will retain the blue foliage into maturity. Grafting pieces from a blue plant onto seedlings will ensure the desired colour in the mature trees.







TO OBTAIN A PARTICUIAR PLANT FORM. By grafting particular combinations, it is possible to obtain effects such as the standard rose or weeping cherry.

TO OBTAIN RESISTANCE TO DISEASE OR SOME ENVIRONMENTAL EFFECT.

Prostanthera can be grafted onto the roots of westringia to avoid the effects of cinnamon fungus (a disease which attacks plant roots). Westringia is not affected by this disease but prostanthera is highly susceptible. If peaches are to be planted in areas suffering from bad drainage, they are best grafted onto plum rootstocks. Peaches are very susceptible to waterlogging but plums are not.

TO OBTAIN MORE THAN ONE VARIETY ON THE SAME PLANT. It is possible to have three or four different apples on the one rootstock. or an almond apricot and peach all on the same tree. Overall the tree will be no bigger than normal but by using grafting this way, it is possible for the home gardener to avoid having too much fruit one week and then nothing for the rest of the year.

TO DWARF A NORMALLY LARGE PLANT. If a scion from a larger variety is grafted onto the rootstock of a smaller one, a smaller plant of the desired variety is usually obtained.

TO HASTEN FRUITING OR FLOWERING. Many plants can take many years to produce fruit or flowers. Budding or grafting can greatly reduce the time taken before the plant produces.

TO OBTAIN THE BENEFITS OF INTERSTOCKS. Interstocks can be used for many different reasons, including improving disease resistance or cold hardiness; dwarfing or increasing vigour; allowing two incompatible varieties to be joined (if they are both compatible with the interstock).

OTHER USES APART FROM PROPAGATION. Budding and grafting is used by the horticulturalist in other areas than propagation, e.g. repairing damaged plants, changing the variety of an established plant, rejuvenating old plants and in the study of some diseases.

For any budding or grafting operation to be successful, the following conditions must all be met:

- the stock and scion must be compatible; they must come from two plants closely enough related that they are able to grow together
- the cambiums of the scion and stock must be touching
- the operation should be carried out at a time of the year when the stock and scion are in the appropriate physiological condition. Usually plants are budded in early autumn and grafted in late winter or early spring. It is rarely advised that you should bud or graft when the plant is growing rapidly
- the area of the operation should be sealed immediately after joining both to prevent drying out and to hold the scion or bud in position on the stock
- proper aftercare should be given. Shoots coming from the stock below the union should be removed. If growth of the stock plant is left on the plant above where the union is made, this should be cut off as soon as it is certain the bud or graft has been successful. If plastic tape is used to seal the union, this should also be removed as soon as success is certain, otherwise it will choke the plant.

What Can be Grafted?

The tables on the following page show plants that are commonly propagated by grafting in the Australian nursery industry.

Rootstocks For Fruiting Plants Grown In The Open Ground

Type of Plant	Rootstock	How to Propagate Stock
Apple	Northern Spy	Mound or Stool layering
	Statesman	Seed
	Malling hybrids	Mound layering
Pear	Keiffer	Seed
Plum	Elberta Peach	Seed
	Myrobalan Plum	Hardwood cuttings
Peach	Elberta Peach	Seed
	Myrobalan Plum	Hardwood cuttings
Apricot	Elberta Peach	Seed
	Myrobalan Plum	Hardwood cuttings
	Apricot Seedlings	
Nectarine	Elberta Peach	Seed
	Myrobalan Plum	Hardwood cuttings
Almond	Elberta Peach	Seed
	Myrobalan Plum	Cuttings
	Chellaston Almond	Seed
Cherry	Mazzard	Seed
	$F^{12}/_{1}$	Stool layering
Citrus	Citronelle	Seed
	Citrange	Seed

It is sometimes a difficult matter for the new nurseryman to obtain material to propagate rootstocks. You can, if nothing else, buy budded or grafted plants and propagate rootstocks from the root system and stump of these. Statesman apples and Keiffer pears are grown and marketed to the public for eating. Though not the most common varieties of apple and pear, with a little hunting they can be found and used as a source of seed. Elberta peach seed is able to be purchased from canneries which use this variety commonly. Myrobalan plum is the cherry plum (green leafed and small red fruit with thorns on older wood) which is often found growing wild along roadsides in old orchard areas. Cuttings can be taken from these trees in winter. It is more difficult to obtain rootstock material for cherry and citrus. Most nurseries maintain their own source of stock material which was originally obtained from a horticultural research station or from another nurseryman.

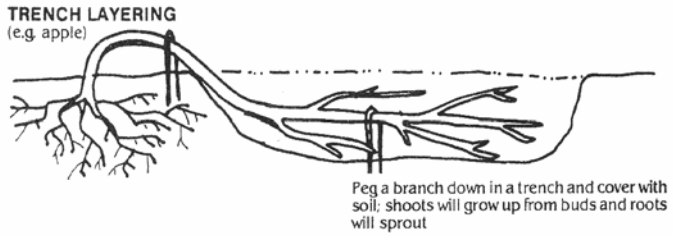
Rootstocks For Ornamental Plants

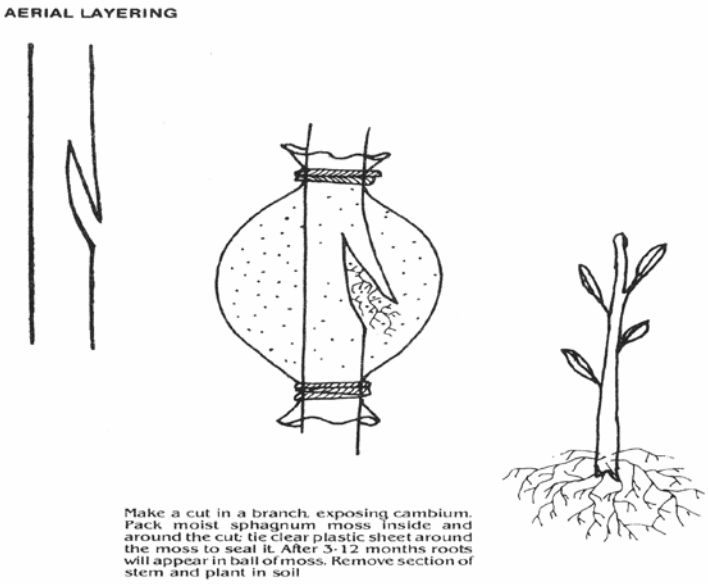
Type of Plant	Rootstock	How to Propagate Stock
Blue Spruce	Picea abies	Seed sown spring after stratification.
Blue Cedar	Cedrus deodara	Seed
Acer	Acer negundo	Seed
Agonis flexuosa variegated	Agonis flexuosa	Seed
Betula	Betula alba	Seed
Fagus species	Common Beech	Seed
Fraxinus (Ash)	Fraxinus oxycarpa (Desert Ash)	Seed
Crab Apple	Statesman	Seed
	Northern Spy	Layering
Prunus amygdalus	Elberta	Seed
Prunus cerasifera	Myrobalan plum	Hardwood cuttings
Prunus mume	Elberta	Seed
Prunus persica	Elberta	Seed
Quercus (Oak)	Quercus robur	Seed
Lilac	Ligustrum ovalifolium (Privet)	Seed or cuttings

Layering

Layering involves developing roots and a stem while the new plant is still attached to its parent. The rooted section can then be cut off to become an independent plant. There are many different techniques of layering as shown in the diagrams. The main advantage of layering is that the established parent plant is able to 'nurse' along the newly developing plant until it is able to support itself. This greatly reduces the risk of failure in propagation. A major disadvantage of layering, however, is that generally it is more involved and time consuming than other techniques.

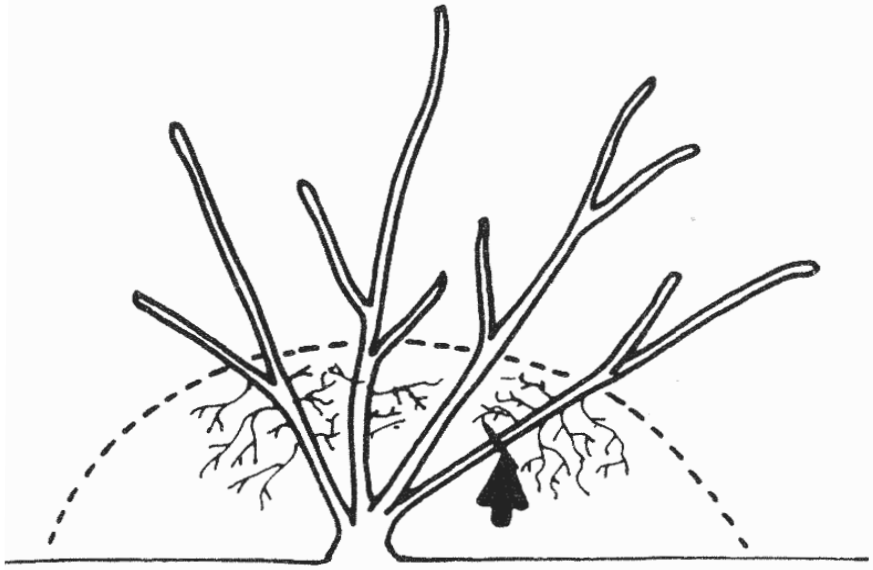
With some plants, layering can be helped along by cutting the layered section, exposing the cambium from which a new root system will develop, or by treating the layer with a hormone such as IBA.

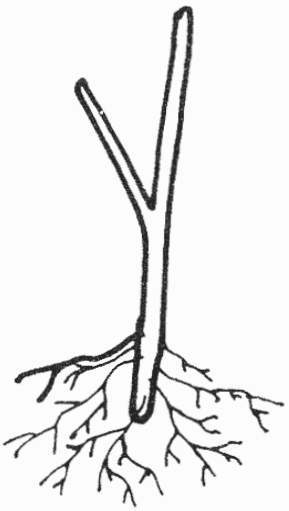




MOUND LAYERING
(e.g. blackcurrant)

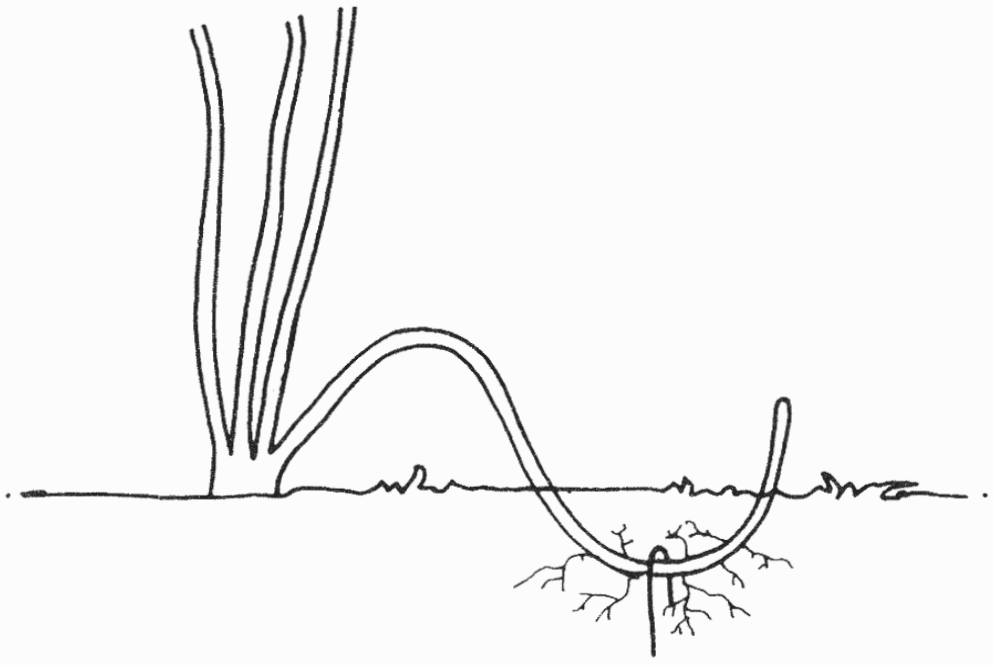
heap soil around shoots in winter; roots will grow out





remove rooted pieces in following winter

SIMPLE LAYERING



Pull a branch over and peg it under the ground

PROPAGATION OF SPECIFIC PLANTS

This chapter is a quick reference guide to growing specific plants. For easy reference, plants are listed in the following groups:

ORNAMENTALS. These include woody trees, shrubs, creepers and climbers (tropical, temperate climate and indoor plants) which are grown for purposes other than cropping.

ANNUALS, BULBS AND PERENNIALS. Grown for their flowers.

FRUIT AND NUT PLANTS. This includes trees, vines and berries.

VEGETABLES

HERBS

The following coding system is used in the plant lists to indicate information relating to propagation.

Method of Propagation (Method):

- S - plant can be grown from seed
- V - plant can be grown vegetatively

For seed propagated plants:

- n - no pre-germination treatment required
- hw - treat seed with hot water before sowing
- b - pre-germination burning often used in the past
- st - stratification (cold treatment) required

For vegetatively propagated plants:

- r - propagated by runners
- l - by layering
- g - by grafting
- x - by cuttings
- cr - by root cuttings
- cl - by leaf cuttings
- y - by suckers
- d - by separation or division
- b - by budding
- cs - by stem cuttings
- cx - by leaf bud cuttings

Where to Propagate (Place):

- OG - open ground; protection of a glasshouse or cold frame is not necessary
- GL - best under glass (ie. in a house or frame)
- Ghm - heating and misting needed to be sure of good results

Ease of Propagation (Ease):

- E - relatively easy to propagate (this does not mean quick!)
- A - average ease; provided you do as is recommended, no great difficulty will be encountered
- D - difficult; some degree of skill and perhaps luck is needed
- S - results can be spasmodic

ORNAMENTALS

Plant	Method	Place	Ease	Other Comments
Abelia	Vcs	GL	A	Feb-Apr
Abies (Fir)	Sst	OG	A	Use only fresh seed
Abutilon	Vcs	GL	A	Feb-March or July-Aug
Acacia (Wattle)	Shw	GL	E	Usually Sept. All year OK
Acer (Maple)	Sst	OG	A	Best in cooler climates
Acer (Maple)	Vbg	OG	0	Onto seedling rootstock
Achimenes	Vcl,cs	Ghm	A	Spring
Adiantum (Maidenhair Fern)	S	Shade	A	Needs very moist, shaded situation
Akebia	Vxy	Ghm	A	Autumn
Albizzia	Shw	GL	E	All year
Alnus (Alder)	Sst	OG	E	Spring
Alnus (Alder)	Vcs	OG	E	Winter
Andromeda	Vcs	Ghm	A	Feb-March
Anigozanthus	Sb	GL	S	Aug-Sept
Anthurium	Sn	Ghm	0	Fresh seed
Anthurium	Vd	Ghm	A	Early spring
Aralia	Sn	Ghm	A	
Arbutus	Sn	GL	A	Sow spring (early)
Asparagus Fern	Sn	GL	A	20°C needed to germinate
Aspidistra	Vd	OG/GL	E	Any time
Atriplex (Saltbush)	Vcs	GL	E	
Aucuba	Vcs	GL	A	Slow to strike. Feb-March
Azalea indica	Vcs	GL	A	Feb-March
Azalea mollis	Vcs	GL	A	Winter
Bamboo	Vldy	OG	E	Anytime
Banksia Needs	Sb	GL	A	15-18°C to germinate for more
Banksia Needs	Vg		D	difficult species
Bauhinia	Vcs	GL	A	Summer; heat and mist useful
Beaufortia	Vcs	GL	A	Feb-March
Begonia	Vcl	GL/Ghm	A	Any time but can be slow
Beloperone (Shrimp)	Vcs	GL	A	Early spring
Berberis	Vcs	GL	A	Winter
Betula (Birch)	Sst	OG	A	Winter
Betula (Birch)	Vbg	OG	A	Onto seedling B. alba
Blandfordia	Sn	GL	A	
Blandfordia	Vd	OG	E	
Boronia	Vcs	GL	A	Feb-March. Seedling plants take too long to flower
Bougainvillea	Vcs	Ghm	D	Early spring
Bouvardia	Vcs	GL	A	Dec-March
Brachycome	Vcs	GL/OG	E	Most of the year
Brachysema	Vcs	GL	A	Feb-March
Brassaia (Umbrella Plant)	Sn	GL	A	
Bromelaids	Vyd	GL/OG	E	Anytime
Browallia	Vcs	GL	A	Autumn
Buddleia	Vcs	GL	A	Winter
Buxus (Box)	Vcs	GL	A	Autumn; slow
Cactus	Vcs Sn	OG/GL	A	Seed little more difficult to start
Calceolaria	Vcs	GL	E	Autumn

Plant	Method	Place	Ease	Other Comments
Callistemon	Sn	GL	E	Sept best
Calluna	Vcs	GL	A	Spring or autumn
Calluna	Vd	OG	A	
Calodendrum	Vcs	Ghm	A	Summer
Camellia	Vcs	Ghm	A	Midsummer-early autumn
Camellia	Vgl	Ghm	D	Grafted to seedling stock
Cassia	Shw	GL	E	Any time but usually spring
Cassia	Vcs	Ghm	A	Winter
Ceanothus	Vcs	GL	A	Feb-March
Cedrela	Vcr	GL	A	
Cedrus (Cedar)	S Vg	OG	D	Soak seed 3 hrs in cold water first
Cercis	S VI	GL	A	Needs 13-18°C for germination
Ceropegia (Chain of Hearts)	Vcs	GL	E	Anytime; best in warmer months
Cestrum	Vcs	GL	A	Autumn and winter
Chamaecyparis	Vcs	GL	E-A	Autumn/winter; slow
Choisya	Vcs	GL	A	Feb-March
Chorizema	Shw	GL	A	
Chorizema	Vcs	Ghm	D	
Cinnamomum (Camphor Laurel)	Vcs	Ghm	A	Ideal temp. 27°C
Cistus (Rock Rose)	Vcs	GL	A	Feb-March; July-Aug
Clematis	Sn Vcs	GL	A	Heating and misting
Clematis	VI	OG	A	advantageous
Clethra	Vcs	GL	A	Feb-March
Clianthus	Shw	GL	A	Cuttings sometimes work
Codiaeum (Croton)	Vcs	Ghm	A	Anytime
Coleus	Vcs	Ghm	A	Spring
Coleus	Sn	Ghm	S	Late winter
Convolvulus	Vd	OG	E	Anytime
Coprosma	Vcs	GL	E	Can be slow; Feb-March; June-July
Cordyline	Sn	GL	A	Usually Aug-Sept
Cornus (Dogwood)	Vcs	OG	A	Winter
Cornus (Dogwood)	Vlyd	OG	A	
Corokia	Vcs	Ghm	A	Autumn
Correa	Vcs	GL	A	Feb-March
Cortaderia (Pampas)	Sn	GL	A	Needs 13°C to germinate
Cotoneaster	Sst	GL	A	
Crataegus	Sst	GL	A	
Crataegus	Vbg	OG	A	
Crowea	Vcs	GL	A	Feb-March
Cryptomeria	Vcs	GL	A	Shade cuttings for first few weeks
Cuphea (Cigar Plant)	Vcs	GL	A	Feb-March
Cupressus (Cypress)	Sst	OG	A	Spring/late winter
Cupressus (Cypress)	Vcs	GL	A	Winter
Cyclamen	Sn	GL	A	Keep seed dark and moist until up
Cydonia (Japonica)	Vcs	OG	E	Winter; don't let dry
Dacrydium	Vcs	GL	A	Feb-March
(Huon Pine)	S	GL	A	Early spring; keep cool
Daphne	Vcs	Ghm	A	Dec-Jan; can be slow

Plant	Method	Place	Ease	Other Comments
Darwinia	Vcs	GL	A	Feb-March ideally 10°C
Datura	Vcs	Ghm	A	Spring or autumn
Deutzia	Vcs	Ghm	A	Summer or winter
Dianella (Flax Lily)	Vd	OG	A	Any time
Dianella (Flax Lily)	Sn	GL		Early spring/early autumn
Ditfenbachia	Vcs	Ghm	D	Spring, 25-30°C
Dillwynia	Shw	GL	A	Usually early spring
Diosma	Vcs	GL	A	Spring; heat and mist useful
Doryanthes	Sn	GL	A	
Dracaena	Vcs	Ghm	A	Spring
Dracaena	Sn	Ghm	D	Early spring, 30°C
Elaeagnus	Vcs,l	GL	A	Slow
Epacris	Vcs	GL	A	Feb-March
Erica (Heath)	Vcs	Ghm	A	Spring
Erica (Heath)	Vd	OG	A	Any time provided not too hot
Eriostemon	Vcs	GL	A	Feb-March
Escallonia	Vcs	GL	A	Feb-March; can be slow
Eucalyptus	Sn	GL	A	All year but spring usual
Euonymus	Vcs	GL	A	Slow, Feb-March
Euphorbia	Vcs	GL	E	Any time. Take care - sap is an irritant
Felicia (Agathea)	Vcs	GL	E	Most times, usually autumn
Ferns	Sn	Shade	AS	Can be slow; keep moist and cool
Ficus (Rubber Plant)	Vcs	GL	A	Usually heat and mist
Ficus (Rubber Plant)	VI, cx	GL	A	worthwhile
Forsythia	Vcs	Ghm	A	June-Aug
Fraxinus (Ash)	Sst	OG	E	Late winter
Fraxinus (Ash)	Vbg	OG	A-D	Onto seedling stock
Fuchsia	Vcs	GL	A	Feb-March; June-July Heat and mist useful
Gardenia	Vcs	Ghm	A	Jan-March; can be slow
Garrya (Catkin Plant)	Vcs	GL	A	Feb-March; slow
Ginkgo	Vcs	OG	E	Winter
Gompholobium	Vcs	Ghm	A	Feb-March
Genista (Broom)	Shw	GL	A	
Gordonia	Vcs	GL	A	Heat and mist useful; Feb-March
Grevillea	Vcs	GL	A	Cuttings for shrub types Feb-March
Grevillea	Sb	GL	A	Seed for tree types
Hakea	Sb	GL	A	Slight bottom heat useful
Hardenbergia	Shw	GL	E	Early spring
Hebe (Veronica)	Vcs	GL	E-A	Most times but usually autumn
Hedera (Ivy)	Vcs,cx	GL	A	Most times; without heat and mist can be slow, but still strikes
Helichrysum	Vcs	GL	A	Feb-March best but all year OK
Helichrysum	Vcs	OG	A	provided cuttings don't dry out
Hibbertia	Vcs	GL	A	Any time but usually Feb-March
Hibiscus (evergreen)	Vcs	GL	A	Feb-March
Hibiscus (deciduous)	Vcs	GL	A	June-July
Hoheria	Vcs	GL	A-D	Feb-March; can be slow
Hovea	Shw	GL	A	Cuttings can work under mist
Hoya	Vcs,cx	Ghm	D	Slow at times; 25-30°C

Plant	Method	Place	Ease	Other Comments
Hydrangea	Vcs	OG/GL	E	All year
Hypericum	Vcs	GL	A	Autumn
Indigofera	Shw	GL	A	Any time, best early spring
Jacaranda	Vcs	Ghm	A	Feb-March
Jasminum (Jasmine)	Vcs	GL	A	Most times; heat and mist useful
Juniperus (Juniper)	Vcs	GL	A	Winter or Feb-March; 15°C; slow sometimes
Kennedya (Coral Pea)	Shw	GL	E	Insects often damage seeds
Kerria	Vcs	Ghm	A	Feb-March
Laburnum	Shw	OG	A	
Laburnum	Vg	OG	A	
Lagerstroemia (Crepe Myrtle)	Vcs	GL	A	Feb-March; June-July
Lagunaria	Sn	GL	A	Usually early spring
Lantana	Vcs	GL	E	Most times, usually Feb-March
Leonotis	Vcs	GL	A	Feb-March
Leptospermum	Vcs	GL	A	Most of the year, best autumn
Leptospermum	Sn	GL	A	Usually spring
Leschenaultia	Vcs	GL	E	Any time; slower in cooler months
Leucodendron	Sb	GL	D	Usually early spring
Ligustrum (Privet)	Vcs,g	GL	E-A	Variegated forms sometime grafted
Lippia	Vcs	Ghm	A	Spring
Liquidambar	Sst	OG	A	Seed does not keep long
Liquidambar	Vcr	GL	A	
Liriodendron	Sst	OG	A	Winter; seed is main method
Liriodendron	Vcs,cr	GL	A	Summer
Lonicera (Honeysuckle)	Vcs	GL	A	Feb-March
Lotus	Vcs	GL	E	All year
Luculia	Vcs	Ghm	A	Summer
Magnolia (evergreen)	Vcs	GL	A	Feb-March
Magnolia (evergreen)	Vl	OG	A	Spring - most times
Magnolia (deciduous)	Vcs	GL	A	Winter
Magnolia (deciduous)	Vl	OG	A	Most times
Mahonia	Vcs	Ghm	A	Feb-March
Maranta	Vd	GL	E	
Melaleuca	Sn	GL	A	Anytime
Melia	Sst	OG/GL	A	Winter
Melia	Vcs	OG/GL	A	Winter
Metrosideros	Vcs	Ghm	A	December
Monstera	Sn	Ghm	A	Spring - don't let seed dry
Monstera	Vcs	Ghm	A	Most times; best in warmer months
Myrtus (Myrtle)	Vcs	GL	A	Can be slow, faster with heat
Nandina (False Bamboo)	Vcs	GL	S	Summer; usually slow
Nerium (Oleander)	Vcs	GL	A	Feb-March
Olearia	Vcs	GL	A	Feb-March
Orchids	Vd	GL	A-D	Varies through varieties
Palms	Sn	GL	S	Any time; very irregular - out of the same batch some take a few months and others several years.
Pandorea	Vcs	GL	A	Feb-March
Passiflora	Sn	GL	E	Anytime
Peperomia	Vd,cx	Ghm	A	Spring

Plant	Method	Place	Ease	Other Comments
Philadelphus	Vcs	GL	A	Feb-March
Philodendron	Vcs,1, Vcx	Ghm	A	Spring
Photinia	Vcs	GL	A	Any time; can be slow
Picea (Spruce)	Sst	GL/OG	A	Winter (late)
Picea (Spruce)	Vg	OG	D	Blue spruce grafted on seedlings
Pieris	S Vl	GL	A-D	
Pimelea	Vcs	GL	A	Feb-March
Pinus (Pine)	Sst	GL	A	Late winter
Piper	Vcs	Ghm	A-D	Autumn; not too much water at first
Pittosporum	Sn	GL	A	Any time
Pittosporum	Vcs	Ghm	A	Feb-March; can be slow
Platanus (Plane)	Vcs	OG	E	Winter
Plumaria (Frangipani)	Vcs	Ghm	A	Spring 18-25°C
Plumbago (Leadwort)	Vcs	GL	A	Feb-March; June-Aug
Populus	Vbg,cs	OG	A	Winter - cuttings; sucker-grown plants tend to sucker excessively
Prostanthera	Vcs	GL	A	Feb-March
Protea	Sb	GL	SD	Early spring
Prunus	Vbg	OG	A-D	Rootstock varieties from both hardwood cuttings and seed (st)
Pultenea	Shw	GL	A	
Pultenea	Vcs	Ghm	A	Spring
Pyracantha	Sst	GL	A	
Quercus (Oak)	Sst	OG	A	Seedlings usually for
Quercus (Oak)	Vbg	OG	A-D	rootstocks; sown winter
Ravenala (Traveller's Palm)	Vy	OG	A	Anytime
Rhaphiolepis	Vcs	Ghm	A	Feb-March
Rhododendron	Vcs	Ghm	A-D	Feb-March
Rhus	Vcs,cr	GL	A	Autumn; can be slow
Rhus	Vbg			
Robinia	Shw	GL	E	Usually Sept; all year OK
Rosa (Rose)	Vbg	OG	A	Rootstocks from cuttings of vigorous varieties in winter
Saintpaulia (African Violet)	Vcl	Ghm	A-D	Spring
Salix (Willow)	Vcs	OG	E	
Salvia	Vcs	GL	E-A	Autumn and winter
Sansevieria	Vcl	Ghm	A	Spring; be careful not to over water
Sequoia (Redwood)	Sst	OG	A	Winter
Sollya	Vcs	Ghm	A	Feb-March
Spirea	Vcs	GL	A	Feb-March; June-July
Stenocarpus	Sb	GL	A-D	Early spring
Swainsonia	S	GL	A	Soak seed 1hr in tepid water
Syringa (Lilac)	Vbg	OG	A	On privet rootstock
Tamarix (Tamarisk)	Vcs	OG	E	Winter
Taxus (Yew)	Vcs	GL	A	Winter; usually slow
Telopea (Waratah)	Sb	GL	A-D	Usually spring
Tetrapanax (Rice Paper Tree)	Vcs	GL	A	Mid-spring
Thryptomene	Vcs	GL	A	Feb-March
Thuja	Vcs	GL	A	Winter; can be slow.
Tilia (Linden)	Sn Vbg	GL	A	

Tristania	Sn	GL	A	Any time but usually early spring
Ulmus (Elm)	Sst	OG	A	
Ulmus (Elm)	Vbg	OG	A-D	Some species put in seedling stock
Verbena	Vcs	GL	A	Autumn or winter
Viburnum	Vcs	GL	A	Autumn or winter; heat and mist are worthwhile
Vitis (Vine)	Vcs	OG	E	
Weigela	Vcs	OG/GL	A	Feb-March; June-July
Westringia	Vcs	GL	A	
Wisteria	Vcs	Ghm	A-D	Summer
Wisteria	Vl	OG/GL	A	Does not transplant well - layer straight into containers
Yucca	Vs, cr	OG	A	Root cuttings in spring

ANNUALS, BULBS AND PERENNIALS

Plant	Method	Place	Ease	Other Comments
Agapanthus	Vd	OG	E	Spring
Ageratum	Sn	OG/GL	E	24°C for germination
Alyssum	Sn	OG/GL	E	All seasons; warmth speeds germination
Althaea (Hollyhock)	Sn	GL	E	Autumn-spring
Amaryllis (Belladonna)	Vd	OG	E	
Amaryllis (Belladonna)	V	GL	A	Bulb cuttings
Anemone	Sn Vd,cr	OG/GL	E-A	
Antirrhinum (Snapdragon)	Sn	GL	E-A	Light and mist beneficial
Aquilegia (Columbine)	Sn Vd	GL	E-A	Autumn or spring
Aster	Sn Vd	GL	E-A	Divide anytime; seed better in autumn or spring
Arum	Vd	OG	E	Anytime
Begonia	Sn	GL	E-A	Annual types 20°C
Bellis (English Daisy)	Sn	GL	E-A	Autumn-winter
Bellis (English Daisy)	Vd	OG	E	
Calendula	Sn	GL/OG	E	Autumn-early spring
Calceolaria	Sn Vcs	GL	E-A	Feb-March
Campanula	Sn Vd	GL/OG	E-A	Spring and autumn
Canna	Vd	OG	E	Anytime
Canna	S	GL	E	Scarify seed to break coat
Carnation	Sn Vcs	GL/Ghm	E-A	Any time; virus-free cutting material is essential; also tissue culture
Chrysanthemum	Vcs	GL/Ghm	E	Aug-Sept from young growth
Clivia	Vd	OG	E	July-Sept
Colchicum	Sst Vd	OG	E-A	Aug-Sept
Cineraria	Sn	GL	E-A	Feb-March
Coleus	Sn Vcs	GL	A	July-Aug
Convallaria (Lily of the Valley)	Vd	OG	E	August
Cosmos	Sn	GL	E	Early spring, 25°C
Crocus	Sn Vd	OG/GL	E-A	Seedlings take few years to flower
Cyclamen	Sn	GL	A	Keep seed dark and moist until up
Dahlia	Sn Vcs	GL	A	Spring; get seedling
Dahlia	Vd	OG	E	variation
Delphinium	Sn Vd	OG	E-A	May-Aug
Delphinium	Vcs	GL	E-A	Spring
Dianthus (Pinks)	Sn Vd	OG/GL	E-A	Autumn

Plant	Method	Place	Ease	Other Comments
Dianthus (Pinks)	Vcs			
Digitalis (Foxglove)	Sn	GL	E	Spring; 25°C; responds to light
Dierama (Sparaxis)	Sn Vd	GL	E-A	Seed easier than division; spring
Echinops	Sn Vcr	GL	E-A	Autumn
Echinops	Vd	OG	E	Spring
Filipendula	Vd	OG	E	May-Sept
Freesia	Sn	OG	E-A	12°C for germination
Freesia	Vd	OG	E	
Gazania	Vcs Sn	GL	E	Feb-March usual but any time OK
Geranium	Vcs	GL	E	Anytime
Gerbera	Vcs	GL	A	Spring/summer
Gerbera	Sn	GL	A	Dec-Jan; use very fresh seed
Geum	Sn Vd	OG/GL	E-A	Seed needs 25°C
Gladiolus	Vd	OG	E	Corms can also be cut in pieces each containing an eye
Gypsophila	Vcs	GL	A	Spring
Gypsophila	Sn	GL	E-A	Spring or autumn
Helianthus (Sunflower)	Sn	OG	E	Spring
Helleborus (Christmas Rose)	Sst	OG	E-A	Spring; seed needs 6 weeks
Helleborus (Christmas Rose)	Vd	OG	E	moist chill
Hemerocallis (Day Lily)	Sst	GL/OG	E-A	Seed needs 6 weeks moist chill
Hemerocallis (Day Lily)	Vd	OG		
Hippeastrum	Sn	GL	A	25°C for germination
Hippeastrum	Vx	OG	A	Bulb cuttings February
Hollyhock	Sn	GL	E	Autumn-winter
Hyacinthus (Hyacinth)	Scoring	GL	E-A	Damaging base of bulb promotes formation of bulblets
Iberis	Sn Vd	OG/GL	E-A	Seed under glass 25°C
Impatiens (Balsam)	Sn	GL	E	20°C for germination
Ipomea (Morning Glory)	S	GL	E-A	Notch seed coat before planting 25°C
Iris	Vd	OG	E	Divide after flowering
Kniphofia	Vd	OG	E	Divide after flowering
Kochia	Sn	GL	E-A	Winter, avoid frost
Lachenalia	Vcl	GL	A	
Lilium (Lily)		GL	E	Takes 3 years to flower
Lilium (Lily)	Vcs	GL	E	Scale cuttings
Lilium (Lily)	Vd	OG	E	
Lobelia	Sn	GL	E-A	Autumn-winter 25°C
Lupinus (Lupin)	Sn	GL	E	Sometimes scarify seed, 20°C
Mesembryanthemum (Pigface)	Sn Vcs	OG/GL	E	
Muscari (Grape Hyacinth)	Vcl, d	OG/GL	E	Cuttings under glass
Narcissus (Daffodil)	Vd	OG	E	Bulb cuttings
Nemesia	Sn	GL	E-A	Autumn-winter
Nerine	Vd	OG	E	
Nicotiana (Tobacco)	Sn	GL	E	Aug; plant out after frost
Pansy	Sn	GL	E-A	Winter and autumn
Paeonia (Peony)	Sst Vd	OG	DS	Protect over winter; seedlings can take 2 years
Papaver (Poppy)	Sn	GL	E-A	Any time except midsummer
Pentstemon	Sn Vcs	GL	A	Summer, spring
Petunia	Sn	GL	A	Spring; mix fine seed with sand to spread evenly

Plant	Method	Place	Ease	Other Comments
Phlox	Sn Vcs	GL	E-A	Ripe seed autumn 20°C
Phlox	Vd	OG	E	
Phormium (Flax)	Sn	GL	A	Any time
Polyanthus	Sn	GL	A	Sept-Nov
Primula (Primrose)	Sn	GL	E-A	18°C to germinate
Primula (Primrose)	Vcs	GL	A	Spring
Ranunculus	Sn Vd	OG/GL	E	Winter
Rudbeckia	Sn Vd	OG/GL	E	25°C for seed, autumn-winter
Saxifraga	Sn Vdr	og	e	Fresh seed best
Scilla (Squill)	Vd	OG	E-A	Bulb cuttings
Stock	Sn	GL	E-A	Autumn
Sparaxis	Sn	OG	E-A	Only fresh seed. December
Sprekelia		OG	A	Bulb cuttings
Sweet Pea	Sn	OG	E	Spring-summer
Sweet William	Sn	GL/OG	E-A	Spring-summer
Stachys (Lamb's Tongue)	Vd	OG	A	
Tagates (Marigold)	Sn	OG/GL	E	Spring, 25°C needed
Tulip	Vd	OG	A	Needs cold climate
Trollius	Sn Vd	OG	E-A	Seed germinates slowly
Verbena	Sn Vcs	GL	A	Summer cuttings; seed 25°C
Vinca (Periwinkle)	Vcs,d	GL	E	
Viola (Violet)	Vd, cs	OG/GL	E	Seed sometimes used
Watsonia	Vd	OG	E	
Zinnia	Sn	GL	E	Spring

FRUIT AND NUT PLANTS

Plant	Method	Place	Ease	Other Comments
Almond	Vbg	OG	A-D	On peach or plum stock
Apple	Vbg	OG	A-D	On apple or quince stock
Apricot	Vbg	OG	A-D	On peach or plum stock
Avocado	Vbg	OG/GL	A-D	Avocado seedling stock; select budwood carefully
Banana	Vdy	OG	E-A	Cut into 3-4 kg pieces
Blackcurrant	Vcs	OG	E-A	Winter
Blueberry	Vcs	Ohm	A	Summer; transplant following spring
Bramble Fruit	Vy,l,cs	GL/OG	E-A	
Cape Gooseberry	Sn	GL	A	Late winter (avoid frost)
Carob (Ceratonia)	S	GL	A	Spring, 30°C, may need some soaking in water
Cacao (Cocoa)	S	GL	A	Use only mature seed; prevent drying, 25-30°C for germination
Cashew	Sn	OG	E	Sow direct don't transplant except in very warm climates
Castanea (Chestnut)	Vg	OG	A	On seedling stock. Seedling trees take 20 years to bear
Cherry	Vbg	OG	A-D	On cherry rootstocks
Citrus	Vb	OG	D	On citrus rootstocks
	Vcs	Ghm	A	Does not produce such vigrous or reliable plants
Coconut	Sn	OG/GL	S	Plant 30cm apart in bed, stem end of fruit slightly raised; plant with nut still in husk or shell

Plant	Method	Place	Ease	Other Comments
Coffee	Sn	Shade	A	Fresh seed - do not allow to dry! Select seed from good plants
Cranberry	Vcs	OG	E-A	Cuttings set in permanent location - not transplanted
Currant (black or red)	Vcs	OG	E	Winter; currants need a cold climate to grow well
Date Palm	Vsd	OG	D	Grown by offshoots to ensure the sex is known. Be careful not to let roots of offshoot dry out.
Feijoa (Pineapple Guava)	Vcs, g	Ghm	A	Grafted to seedlings; cuttings in Feb-March
Fig	Vcs	OG	E	Winter
Filbert	Sst	OG	A	Seedlings only for rootstocks
Filbert	Vlbg	OG	A	Layering done on suckers
Gooseberry	Vl	OG	E	Mound layering
Grape	Vcs gb	OG	E-A	Cuttings in winter is main method
Grapefruit				See Citrus
Guava (Psidium)	S Vbg	GL	D	Seedlings very susceptible to damping off. Vegetative propagation extremely difficult
Guava (Psidium)	Vl (Air)			
Hickory (Carya)	Vbg	OG	A-D	Seedling rootstocks. Seed germinated spring - no preselect treatment
Hazelnut (Corylus)	S Vbg	OG	A	Improved varieties grafted
Kiwi Fruit (Chinese Gooseberry)	Vg	OG/GL	A-D	On seedling stock to assure knowledge of plant's sex
Lemon				See Citrus
Loganberry				See Bramble Fruit
Loquat	Vbg	OG	A	Loquat seedlings or quince as rootstock
Lychee	Vl (Air)	OG	A	Other asexual methods successful. Seedlings take too long to bear.
Macadamia	Shw	GL	A	Don't crack seed coat!
Macadamia	Vbg, cs	GL/OG	D	
Mandarin				See Citrus
Mango	S	GL	A	Fresh seed, remove endocarp before planting, Vegetative methods less common
Mango	Vbg			
Mango	Vcs			
Medlar	Sst	OG	A	Seed sown spring
Medlar	Vbg	OG	A-D	Pear, quince or hawthorn rootstocks
Mulberry	Vcs	GL	E-A	Early spring
Nectarine				See Peach
Olive	Vcs	GL	A	Feb-March or winter cuttings
Olive	Vbg	OG	A-D	Seedling rootstocks
Orange				See Citrus
Papaya	Sn	GL	A	Watch for damping off
Passionfruit	Sn	GL	E-A	Sometimes grafted onto fusarium - resistant stock
Pawpaw	Sst	OG	A	Early spring; protect from sun; difficult to transplant after first year's growth
Peach	Vbg	OG	A-D	On peach or plum rootstock
Peanut	Sn	OG	E	Needs warm frost-free climate
Pear	Vbg	OG	A-D	On pear or quince rootstock
Pecan	Vbg	OG	A-D	On pecan seedlings
Persimmon	Vbg	OG	A-D	On seedling stock. Seeds need stratification period
Pineapple	Vds	OG	E	Cure and dry for a week or two after division before planting
Pistachio	Vb	OG	A-D	On seedling stock in spring

Plant	Method	Place	Ease	Other Comments
Plum	Vbg	OG	A-D	On plum or peach rootstock
Pomegranate	Vcs	Ghm	A	Winter
Quince	Vcs	OG	E	Winter
Raspberry				See Bramble Fruit
Strawberry	Vr	OG	E	Because of disease, they must be controlled and propagated only in a disease-free area
Tamarillo (Tree Tomato)	Vcs	OG	E-A	Winter
Walnut	Vbg	OG	A-D	On seedlings. Seed needs stratification to germinate.

VEGETABLES

Vegetables are all grown from seed even though some will grow by other methods. It is most important with all vegetables to use good seed.

The viability of some vegetable seeds will deteriorate rapidly after one year. With some types of vegetables (e.g. cabbage and lettuce) it is extremely important to plant varieties at the appropriate time of the year. A variety planted outside of the recommended time might germinate but at the very least will not be nearly so productive. Some vegetables do not transplant readily (most root crops, eggplant peas and beans, etc.) and are therefore unsuited to container growing in a nursery.

Some of the less straightforward considerations in vegetable propagation are outlined below:

- **ARTICHOKE (GLOBE).** Suckers from old plants can be transplanted in early spring when about 23 cm high. Seedlings can be transplanted easily.
- ARTICHOKE **(JERUSALEM).** Tubers can be divided in July. Keep a minimum number of eyes or buds on each tuber.
- ASPARAGUS**.** Grow by seed or dividing the crowns in winter.
- BEETROOT**.** One of the few root crops which will transplant
- **BRASSICAS.** Cabbage, cauliflower, broccoli and sprouts will transplant but should be planted at the correct time of year for a variety to grow well.
- CELERY**.** Germination can be helped by soaking the seeds first in water for a few hours.
- EGGPLANT**.** Does not transplant easily. Avoid frosts.
- ONIONS**.** Early white varieties can be grown in autumn-winter as a bulb type or spring-summer as a spring onion.
- TOMATOES**.** Main consideration is to avoid frost.

HERBS

Plant	Method	Place	Ease	Other Comments
Agrimony	Sn	GL	E	Shade seedlings
Aloe	Sn	GL	E-A	21°C required for germination
Angelica	Sn	GL	E-A	Fresh seed essential; only a few days old
Anise	Sn	GL	E	Spring
Apple Mint	Vxyd	OG	E	All year but winter better
Balm	SnVd	OG/GL	E	Spring
Basil	Sn	GL	E	13-15°C for germination. Spring
Bay Laurel	Vcs cr	Ghm	A	Can be done without heat and mist but very slow. Feb- March
Bergamot	Vd	OG	E	
Borage	Sn Vd	GL	E	Spring
Burnet	Sn	GL	E	Spring
Camomile	Vd	OG	E	
Camphor Laurel	Vcs	Ghm	A	Spring
Caraway	Sn	GL	E	Autumn

Plant	Method	Place	Ease	Other Comments
Cardamon	Sn Vd	GL/OG	A	Sow seed in spring; divide in autumn
Cayenne	Sn	GL	E	Mid-spring
Celeriac	Sn	GL	E	Spring; soak seed in water for two hours
Celery Herb				As for celeriac
Chives	Sn Vd	OG	E	Spring
Chervil	Sn	GL	E	
Chicory	Sn	GL	E	Spring
Catnip	Sn Vd	GL/OG	E	
Cinnamon	Vcs	GL	A	Warm climates only
Clarry	Sn Vcs	GL	E	
Coleus canis	Vcs	GL	E-A	Very susceptible to damping off
Comfrey	Vcr, d	OG	E	
Coriander	Sn	GL	E	Spring
Corsican Mint	Vd	OG	E	Any time
Dandelion	Sn Vd	OG	E	Spring
Dill	Sn	GL	E	Spring
Fennel	Sn Vd	GL	E	
Garlic	Vd	OG	E	
Geranium	Vcs	OG/GL	E	Any time
Germander	Vcs	GL	E-A	Feb-March
Germander	Vd	OG	E	Spring
Hemlock (Tsuga)	Vcs	Ghm	A	Winter; slow to root
Horseradish	Vcr Sn	GL	E	
Hyssop	Vcs Sn	GL	E	Likes alkaline conditions
Hyssop	Vd	OG	E	
Juniper	Vcs	GL/Ghm	A	Winter; can be slow
Lad's Love	Vcs	OG/GL	E	OG in winter, GL other times
Lavender	Vcs	GL	A	Winter or spring
Lemon Grass	Vd	OG	E	Needs warmth; avoid frost
Lemon Verbena	Vcs	GL	A	Feb-March
Lovage	Sn	GL	E	
Marigold	Sn	GL	E	Spring
Marjoram	Vcs	OG/GL	E	Any time, easier in winter
Meadowsweet	Vd	OG	E	Spring
Mints	Vd	OG	E	Any time
Mints	Vcs	GL	E	Any time
Mugwort	Vcs	GL	E	Feb-March
Nasturtium	Sn	OG	E	Spring
Nutmeg	Vcs	Ghm	A	Warmer areas only
Oregano	Vd, cs	GL	E	
Parsley	Sn	GL/OG	E	Spring
Pennyroyal	Vd	OG	E	Any time
Pennyroyal	Vcs Sn	GL	E-A	
Peppermint				As for mints
Pyrethrum	Vcs	GL	E	Spring (early)
Rosemary	Vcs	GL	A	Autumn and winter
Rue	Sn Vcs	Gl	E	
Rue	Vcr			
Sage	Vd, cs	GL	E	

Plant	Method	Place	Ease	Other Comments
Savory	Sn	GL	E-A	Seed is slow
Savory	Vcs, d	GL	E	Feb-March
Spearmint				As for mints
Scilla (Squill)	Vd	OG	E	Can be grown from bulb cuttings
Tansy	Vd Sn	OG	E	Seed is slower
Thyme	Sn	GL	E-A	Spring
Thyme	Vcs	GL	A	Feb-March
Thyme	Vdl	OG	E	
Wormwood	Sn	GL	E-A	Slow
Wormwood	Vd, cs	GL/OG	E	Division - OG, cuttings - GL
Yarrow	Vcr	GL	E-A	

HERB PRODUCTION

A large proportion of herbs fall into one of four different plant families:

LABIATAE (MINT FAMILY). This includes balm, basil, catnip, hyssop, lavender, marjoram, all the mints (mentha), oregano, pennyroyal, rosemary, sage, savory and thyme.

UMBELLIFERAE (PARSLEY FAMILY). This includes angelica anise, caraway, dill, fennel and parsley.

COMPOSITAE (DAISY FAMILY). This includes camomile, lad's love, marigold, mugwort, tansy, tarragon, wormwood and yarrow.

LILIACEAE (ONION FAMILY). This includes garlic. chives, shallots and squill.

The leaves of the Labiatae herbs are used for culinary purposes, and the oils from this same group tend to have an insect-repellent quality.

Usually the seeds of Umbelliferae herbs are used for culinary purposes, although in some cases the leaves are important .

Leaves and bulbs of most Liliaceae herbs are edible although exceptions such as squill should be noted. In large quantities, squill is poisonous. It is used in cough medicines in minute proportions.

Lavender, a member of the Labiatae family, is very popular and not difficult to propagate.

Rosemary, a highly prized culinary herb, is another representative of the Labiatae family.

As its appearance suggests, camomile is a member of the daisy family (Compositae); it is used to make a refreshing tea with valuable medicinal properties.

Members ofthe Umbelliferae (parsley family) are characterised by the arrangement of the flowers, which are grouped in umbels.

HERBAL PRODUCTS

There is an almost endless variety of enterprises open to the herb farm. There is a definite difference between the profitable and the interesting possibilities, and the serious new herb farmers might have to modify their ambitions in order to achieve a profit. Most business in the herb farm industry involves the following four areas: production and sale of plants, seeds, dried herbs and herbal oils.

There is a market for a wide range of other herbal products but for the moment this market remains relatively small.

Examples are sachets and potpourris, vinegars, bath salts, oils and cosmetics (generally controlled by the large cosmetic companies), pickles, soaps, jams, medicines, insect-repellent sprays, sauces, sleep pillows, tobacco, incense and scented candles.

Many attractive herbal gift items can be produced for sale in the nursery. Their popularity, however, is largely governed by the degree of attention given to their presentation and display.

Production and Sale of Plants

Herbs are grown for sale in containers and also in the open ground. Growing and selling in 7 to 15 cm diameter pots is more common, but from the open ground, they can be dug in winter and sold bare with only the soil which clings in a ball to the roots.

Most herbs grow well from both seed and cuttings (refer to propagation charts for details). Several herbs are also easily grown from division.

Herbs are a relatively fast-growing group of plants, reaching a saleable size usually within six months of propagation. For this reason, herbs are usually sold at a lower price than woody shrubs and trees. To obtain a reasonable living from a herb nursery, a single person would need to produce and sell between 15,000 and 30,000 plants a year.

A herb farm usually relies heavily on sales of plants but often supplements this with sales of herbal products, books and general nursery lines.

Production of Seed

Seed needs to be harvested when it is mature, just prior to dropping. The experienced seed farmer can know the time almost by instinct but the inexperienced must watch the plants closely.

Perhaps the best indication of the seed's approach to maturity is a colour change (usually from a green to a brown or autumn tone). At this stage, a stocking can be tied over the seed head. When the seed drops, it will be caught by the stocking. The experienced person does not need the stocking for most plants.

Seed will keep best if it is stored dry in a sealed container (not vacuum sealed however). The keeping quality of herb seed varies from one year to five years. Most keep at least two years.

If you are growing seed for sale through your own retail outlet (i.e. to the public on the roadside or at the nursery), you will probably obtain sufficient seed from a couple of plants of each variety. If selling to a seed company, you would grow much larger quantities.

Dried Herbs

Herbs should be dried either indoors or in a specially constructed drying cabinet

It is important that rain does not interrupt the drying process. A herb which half dries, moistens, then continues to dry again, will lose much of its quality.

The main requirements are:

- a fairly constant temperature between 27°C and 32°C (for most- not all)
- good air movement around the herb
- shade for any top growth
- sunlight for drying roots.

Do not dry in any room which might become humid i.e. a kitchen, bathroom, laundry or a room which has indoor plants.

Herbs should be dried immediately they are harvested either spread out on wire mesh shelves or hung upside down so that air can move freely around all parts of the plant. It helps to turn the plants every day or so until dry. When the plant parts will break easily without bending or with little pressure, then they are sufficiently dry. They are then best stored in a dry airtight container.

Herbal Oils

These are made by distilling the oil from the plant parts or by steeping the plant parts in a non-aromatic vegetable oil such as sunflower, safflower, peanut or olive oil.

Rose petals, rosemary or lavender can be crushed then stood in one of these vegetable oils in a sealed jar. If placed in the sun or some other warm position, the aroma of the plant will soon penetrate the oil. Use 5 g of flowers or foliage to 500 ml of oil. Herb cooking or cleansing oils are made in this way.

Distilled oils of some plants are produced on a larger scale for use in certain industries. Lavender, spearmint, peppermint and eucalyptus oils are among the more obvious ones. Melaleuca alternifolia (Tea Tree) is a native paperbark which supplies oil used in the production of fire gel. This is in high demand worldwide.

Potpourri

There are two basic methods of making potpourri: the old-fashioned moist method in which partly dried petals and leaves are mixed with salt and left to mature, and the dry method which is generally preferred today, and which requires a fixative to preserve the scent

Here is a typical recipe for the dry method (the leaves and petals should be completely dry):

4 cups rose petals

2 cups scented geranium leaves

2 cups lavender flowers and leaves

1 cup lemon verbena leaves

2 tablespoons orris root powder (fixative)

1 teaspoon rose geranium oil

1 teaspoon lavender oil

1 teaspoon ground cloves

1 teaspoon ground cinnamon

12 whole flowers.

Mix the above ingredients together in a glass jar and leave sealed for one month. This mix can then be placed into pomanders. These are containers, often made from cane, with holes in them to allow the aroma to be released.

Herb Mixes

There are three common mixtures of dried herbs.

BOUQUET GARNI. Parsley, thyme, bay and sometimes others are used.

This is hung in muslin bags for the aroma or used in cooking.

MIXED HERBS. The standard ‘mixed herbs’ used in cooking are marjoram thyme and sage.

FINES HERBES. Used in cooking. these include chervil, chives, parsley and tarragon.

Herb Sprays

Tahara Herb Farm of Coleraine in Victoria led the way in the late 1970s by introducing a series of herbal insect sprays onto the market. Though still only a minor industry compared with the massive agricultural chemical industry, herbal pest sprays are growing in popularity at a rapid rate. Through new developments and research being carried out at Tahara and other herb farms, this sector of herb farming can be expected to grow significantly in the future.

Herbal insect repellents and insecticides are becoming increasingly popular among organically minded growers.

GARLIC SPRAY. Pour 10 ml of paraffin oil over 90 g of crushed garlic, cover and allow to stand for 48 hours. Make a soap solution using 10 g of soap in 500 ml of hot water.

Pour the soapywater over the garlic and leave covered for one day, then warm the mixture and strain. This can be bottled and should be diluted by adding between 10 and 50 parts of water for spraying.

OTHER SPRAYS. Sprays of sage, wormwood camomile, stinging nettle and others can be made by placing the fresh leaves in boiling water and leaving to stand. After 24 hours, the tea is strained off and stored in a sealed bottle.

Camomile and garlic sprays will control fungus problems to some extent. Wormwood acts as an insect-repellent spray.

Herbal Medicine

Many herbs have positive medicinal value. and some (such as peppermint and eucalyptus) are used extensively in traditional medicine. Be careful though, as there are some herbs which have their use based more on tradition or superstition than sound knowledge. It is advised that prior to production of any medicinal herb products, you should carefully check your source of information.

HISTORY OF A NURSERY

One of the most important points to remember is that skill and knowledge are essential in the operation of a good nursery or herb farm.

If you don't have the skill yourself you are better advised to start small perhaps just as a hobby; learn from your experiences and gradually grow into the type of operation you desire or employ a skilled person right from the beginning.

The following chronology could easily be the way a nursery grows from a hobby into a thriving small business.

- FEBRUARY **FIRST YEAR**. Move into a new home, decide there is a need to get interested in gardening, join a night course, hear a lecture on propagation and decide to experiment at home. 'Maybe I can grow my own plants and save having to buy them'.
- NOVEMBER **THIRD YEAR.** Propagating plants has become such a keen hobby that this year's tax return cheque is spent on buying a small hobby glasshouse.
- JANUARY **FOURTH YEAR.** More than 50 per cent of the plants being propagated die overnight due to a damping-off disease. The dead plants are taken to Department of Agriculture and the problem discovered. All of a sudden there is a realisation that there is more to propagation than meets the eye.
- MARCH **FOURTH YEAR**. Commence studying night classes to learn more. Buy texts, read profusely on everything from pest control to plant identification and soils. Join a couple of garden clubs. Continue to experiment and propagate at home.
- SEPTEMBER **FIFTH YEAR**. Develop a keen interest in eucalypts. Collect and sow seed of as many different eucalypts as possible. Also grow a variety of other plants from both Australia and overseas. Have a strong motivation to grow things not grown previously. Most of the plants grown to date have been either given away to close friends, charities or family.
- APRIL **SIXTH YEAR**. A friend of a friend telephones, says he is looking for plants for a new home and is willing to pay for them. When he comes around.. he buys a lot of shrubs and ground cover but only a few trees, saying he isn't interested in the wide variety of eucalypts which have been grown. It is realised that 'Maybe I can make a living out of this hobby' but also that 'Not everything is saleable'.
- The money from the sale is used to buy a propagating bed. The decision is made to become more serious about the hobby.
- AUGUST **SIXTH YEAR**. While talking to a nurseryman, who is a fellow member of a garden club, decide to show him some plants with the prospect of selling them.
- SEPTEMBER **SIXTH YEAR**. The nurseryman buys a few hundred plants but advises that he would pay more if they were in standard containers, in a lighter weight soil mix and all labelled with printed plant labels.
- JANUARY **SEVENTH YEAR**. Over the summer vacation break, draw up plans and a schedule for what will be grown over that year. Income and expenditure is planned and time is allocated to various tasks on the basis that one day and four nights a week will be spent in developing the nursery.
- JUNE **EIGHTH YEAR**. The backyard is full of plants (more than 12,000). They are selling but not fast enough. A shop site in the local shopping centre is seen to be for sale or lease.
- JULY **EIGHTH YEAR**. The shop site is leased and fencing paid for with savings from plant sales. With the help of friends and family, everything is moved from the backyard to the shop. The wife runs the shop during the week and the husband takes over at weekends. He still holds his job.
- NOVEMBER **EIGHTH YEAR**. After a slow start people are getting to know the nursery and earnings are a few hundred dollars profit each week (for 7 days' work) after paying the rent and other expenses. After visits from Hortico, Yates, Thompson &. Morgan, Attunga etc. a small range of fertilisers, chemicals, seed and soil mixes is stocked.
- JANUARY **NINTH YEAR**. Everyone in the area has gone on holidays and the weekly profit (for 7 days' work) is down to just under the rent.
- FEBRUARY **NINTH YEAR**. A decision is made to advertise in a couple of garden magazines. People are back from holidays and the advertisements pay off. By the end of February, weekly profits are almost up to those of spring.
- MARCH **NINTH YEAR**. The advertising continues to payoff. Weekly profits are now up. Taking a gamble, the husband resigns his job and puts his full-time effort into the nursery, taking charge of propagation while the wife sells.
- OCTOBER **NINTH YEAR**. After a slack period in winter, sales have improved in spring and the weekly earnings, after expenses, are double what they were in November last year.

The type of evolution outlined above is by no means the only way for a nursery or herb farm to develop, but it is probably the most common story. Sometimes people don't go much beyond that initial development into a small part-time backyard operation. There is, amongst some established nurserymen, animosity towards the 'backyarder', the argument normally being that they are 'unprofessional'. This can sometimes make it hard to break into the business. If the beginner can present himself and his product in a more professional or polished way, this problem is usually easily overcome.

Perhaps the most important point of all to remember in the early stages is not to rush. It is safer to allow plant and business expertise to build up slowly and surely.

NURSERY PROFILE

TYPE. Propagation and growing on to medium sizes (14 cm).

STAFFING. One well trained manager (full-time); owners (husband and wife) do potting and other manual work weekends only; additional casual help employed occasionally.

YEAR OF OPERATION. Just commencing third.

LOCATION. Near Woodend, Victoria.

MARKETING. Truck sales to retail nurseries and contract sales, mainly to country nurseries in Victoria and Southern NSW.

VARIETIES GROWN. Advertise anything, seem to concentrate on exotic shrubs and trees.

POTTING MIX. Varies. Components include mountain soil, granitic sand, lignite and scoria (all obtainable locally).

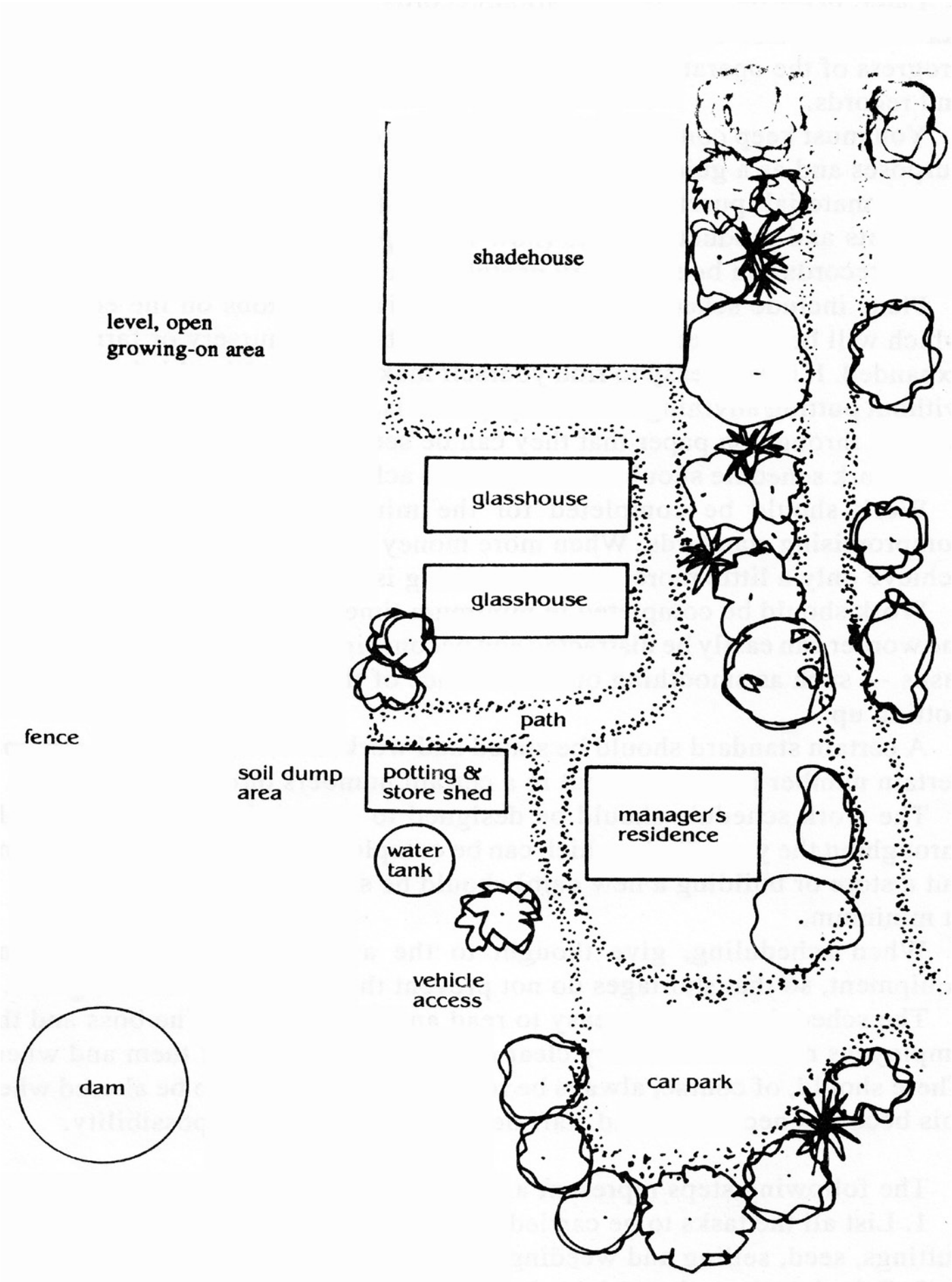
EQUIPMENT AND FACILITIES. Two heated glasshouses with automatic irrigation, heating / misting beds for propagation, shadehouse, steam soil sterilisation, 45,000-litre water tank, average size dam and pumping rights from reliable creek, 0.4 ha growing-on area (only small proportion currently used), 0.4 ha garden for stock plants, approximately 2.5 ha of bush which could be used for expansion.

ANNUAL PRODUCTION. To date a major part of the work has been put into developing facilities, thus turnover still is below 20,000 1.3-15 cm pots.

This will increase to at least 50,000 or 60,000 in the current year.

LAYOUT. Access to all parts of the nursery excellent and flow between areas good.

(The following images are not specifically from this nursery.)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vehicle
access
dam
car park

SETTING UP A COMMERCIAL HERB FARM

By Iain Harrison: Senior Tutor Australian Horticultural Correspondence School (Now ACS Distance Education).

WHY GROW HERBS COMMERCIALLY?

Without doubt the prime reason for growing herbs on a commercial basis is that there is a demand worldwide for herbal products, both fresh and processed. It has been estimated that the demand for spices, condiments and similar products is increasing by, in some cases, more than 20% annually (Miller & Harper: Herb Market Report Vol.5, No.11, 1989). There is considerable potential to grow herbs as an alternative to existing mainstream crops that are in oversupply. There is not much point in producing a product if there is no demand for it. If there is demand, however, and you can produce goods of consistent quality at a competitive price then you should be able to sell your crop profitably.

Angelica seed ready to collect.

Herbs have several other advantages as a commercial crop. Many can be grown in areas with poor soil or limited water supply. Generally much less growing space is required than for more commonly grown crops. The end products are generally small in volume, so storage, packaging, and transport requirements are not usually as high as for other crops.

Many herbs also have high pest and disease resistance so the use of pesticides can be greatly reduced. There is also considerable potential for value added products, for example herb vinegars or wines, craft items, and cooked herb goods.

THE POSSIBILITIES

Herbs can be grown commercially in many different ways, and can be marketed in many different forms. Ways to grow include:

- **Broadacre:** This can be an excellent way of growing larger sized herbs, or where large quantities of the crop are required. This can happen where there is sufficient demand for large quantities of the fresh crop, or when large quantities of the 'raw' crop are required to provide sufficient quantities after processing of the 'finished' crop. For example, processing of essential oils where oil content may be only 1 or 2% of the raw material. Broad acre cropping of herbs can be a good alternative for established growers who are looking for something new to grow. For new growers this type of growing may be very expensive to set up.
- **Intensive in-ground cropping:** This type of cropping is suitable for generally smaller, high yielding crops. Fresh culinary herbs are a good example. This type of cropping will normally be cheaper to establish than broadacre cropping, but will often be quite labour intensive. This can sometimes be an advantage, in times of high unemployment, as a means of creating gainful, satisfying employment.
- **Hydroponics:** Initially expensive to set up the hydroponic systems. Land/space requirements are small and yields can be very high. Pest and disease problems are usually greatly reduced in comparison to in-ground production. Greater technical expertise is required to operate the system in comparison to most in-ground cropping. The crops can be grown at waist, (or other suitable) height, which greatly eases the effort required in planting, maintaining and harvesting the crops. Hydroponic growing has proven very successful for growing fresh salad vegetables. Fresh culinary herbs are also being successfully grown commercially in Australia, the U.S.A, and several European countries.
- A well operated hydroponic system has considerable environmental advantages as well. Nutrient runoff to streams, that is often associated with agricultural production, can be controlled or minimised, and as hydroponic growing is 'soilless' there is greatly reduced demand on our valuable top soils.
- **Containers:** Herbs can be readily grown in containers of all shapes and sizes. This enables them to be readily moved around as desired. You may decide to grow herbs in pots for sale to nurseries or directly to home growers. You could also include herbs in hanging baskets. Another way is to grow culinary herbs in lightweight containers such as polystyrene fruit boxes which can be easily transported to markets, or even hotels and restaurants, so that the herbs can be harvested fresh from the containers as required. For perennial herbs the containers could even be returned to you to allow the herbs to reshoot before harvesting again.
- **Greenhouse Growing:** This type of growing is ideal for the production of crops that may be sensitive to outdoor conditions in your area, or for producing increased yields of other crops. The greenhouses can be initially quite expensive to set up, and this type of cropping can be quite labour intensive. It has the advantages that, like hydroponics, the crops can be grown on benches at a comfortable height, and if good hygiene is maintained then pest, disease and weed problems can be minimised. Greenhouses can be also extremely useful for other types of cropping, as a means of propagating your own planting stock, or for getting stock established early.

TYPES OF HERB GOODS TO PRODUCE

The types of goods that can be produced from herbs is virtually endless. They can be grouped in to a number of main types. These are:

- **Fresh:** principally for culinary use, sometimes as stock feed.
- **Dried:** widely used for culinary use, as floral or dried arrangements, and for providing fragrance.
- **Processed:** this includes those herbs that have further treatment in some way, for example, crushing or powdering. These types are commonly used in medicinals and cosmetics.
- **Essential Oils:** These are widely used as medicinals, for aromatherapy, as flavourings or condiments, as pesticides, as fixatives or bases for other ingredients (ie: in perfumes) and as massage oils.

HARVESTING YOUR HERBS

Herbs are generally harvested by hand, for those where appearance is important (ie: fresh culinary herbs), or by machine, where further processing (ie. distillation) is to take place. Once harvested herbs can rapidly decline in appearance and chemical content if not processed in some way to preserve its quality. Deciding on which way to process your product will depend on what type of herbs you are growing, what type of market you are aiming for, and how much you wish to spend on establishing processing and storage facilities. To get the best from your herbs they should be harvested when they are 'at their best' with regard to appearance (colour, texture, and moisture content or turgor), and at peak concentration of oil and aromatic compounds. There may need to be some compromise between these components as it is rare that they all at their peak at one time. For example, herbs such as rosemary and lavender, which are to be harvested for their oil and other chemicals, have their peak content of these products just before or during flowering, while culinary herbs can often be harvested throughout the growing season.

Ideally harvesting should take place early in the morning to reduce the loss of volatile compounds, and so that the plant material is more easily cooled to the desired storage temperature. Take care to avoid damaging harvested material, as this will result in early its deterioration.

Fresh Herbs

To increase the longevity of fresh herbs they can be refrigerated. Temperatures around 1 to 5 degrees centigrade will suit most leafy herbs. High humidities of around 90 to 95 % in the storage area will help reduce water loss from the harvested material. Plastic wrapping will help maintain humidity levels, but be sure to check regularly for the signs of any rotting occurring. Sealed packaging, soon after harvesting, will also help maintain moisture levels. For longer term controlled atmosphere storage can greatly extend the lifespan, and maintain quality of the product. This type of storage can be quite expensive to establish.

Processed Herbs

There are a number of different processes that can be used to preserve herbs. The most common is drying. On a large scale herbs can be dried in the field. This is very dependant on having good weather conditions, and therefore is only used in areas where weather conditions are consistently good at harvest time and/or other drying methods are prohibitive in cost. For more consistent results, herbs can be dried by laying or hanging them on racks or benches of some type that allows good air circulation. These racks can be rooved to provide weather protection, or in good weather conditions can be left open. Roll up sides can also be used to provide additional protection.

EXAMPLE OF A DRYING SHED

A large galvanised iron farm or work shed, with a concrete slab base can be purchased. Such a shed should have large doors to allow good ventilation. Do not include skylights (e.g. fibreglass or similar sheeting) in the shed walls or roof, as herbs will rapidly lose their volatile oils if exposed to light. Racks can be purchased complete or in kit form from a number of suppliers, or you can make then yourself using either metal or treated timber supports, and wire mesh racking. This can be done for as little as two or three thousand dollars (at the time of writing). Second hand racking can sometimes be purchased at clearing sales, such as those used by dried fruit growers.

For controlled drying, kilns or ovens can be used. These can be initially expensive to set up, but give very good results, depending on the herbs being dried, if operated correctly. For small quantities microwave ovens have shown some promise. Experimentation is the key here to establish the best temperature and drying time.

Freezing has proven successful for many different herbs. As with frozen vegetables, the herbs can be removed in sections/pieces as required, and either thawed before use or added as is. Fermentation can also be used for some types of herbs as a means of preserving their properties. This generally requires some degree of technical knowledge. Licences or permits may be also be required. Distillation of essential oils is becoming increasingly popular, for example, lavender, rosemary, eucalyptus, and Australian tea-tree. As with fermentation greater technical knowledge is necessary, and permits or licences may be required. The distillation equipment can be expensive to install.

CHEMICAL TREATMENTS

Chemicals such as fungicides and bactericides are sometimes applied to inhibit or stop microbial growth, and hence reduce deterioration of the harvested material. Chemicals can also be applied to reduce water loss.

CHOOSING WHAT TO GROW

This is usually the hardest part of growing a new product. Choosing the right one! Very few authoritative statistics are kept in most developed nations, including Australia and the U.S.A. as to how much, what types, and at what price herbal products are sold. What we would consider as being herbal products are often listed under another category for 'official statistics', for example, essential oils may be included under pharmaceuticals. Most writers on the subject agree, however, that there is a consistent increase in annual demand for herbal products in all their forms. This has gained impetus in recent years, in the developed nations, as the trend to more natural based products increases.

Determining what to grow therefore involves some detective work on your part. In other words you have to go out and find what the consumers want. This can be done in a number of ways fairly simply, without involving very extensive market research. While extensive statistics are rarely available, it is possible to obtain some that can be very useful. Bureau of Statistics figures for agricultural production will give you some indication of what types of products are being grown already in this country, while import/export statistics will help you to find out what products are being sold overseas (and where), and which are being imported into the country in large quantities.

State or Regional Departments of Agriculture or Primary Industries can often provide information on which products are in demand, which varieties would be suitable for your area (if you already have a property), where to get good quality varieties, and how to grow them.

Trade or specific interest magazines and journals will often have articles on industry trends, or information on new or uncommon varieties to grow. Grower groups will often provide advice and a source of planting stock.

Simply phoning or visiting wholesalers, nurseries, local restaurants, hotels, produce merchants or brokers can give you a good idea of what is in demand and if there is a shortage or oversupply of particular herbal products. Another alternative is to create your own market by growing something that is unusual or new. There is also considerable potential for 'value added' products.

Once you have chosen what variety or type of herb to grow it is then very important that you get the best variety of that herb or herbs for your situation. This can often be very hard to do.

Little selection work to choose the best cultivars of herbs has been carried out, in comparison to other crop types. Notable exceptions, in Australia, are for high oil producing varieties of Lavender, Australian Tea-tree (Melaleuca alternifolia) and Peppermint.

The Lavender farm at Lilydale in Tasmania, has run a comprehensive selection program, using extensive field trialing and chemical analysis, to choose the cultivars of Lavandula angustifolia that are the best yielding and have the highest quality oil, for more than 40 years.

Likewise the Thursday Island Tea-tree plantation has run similarly extensive programs to choose the best cultivars of Melaleuca alternifolia. These programs have involved considerable time and money, and the companies involved obviously wish to keep control of those cultivars.

If you wish to produce herbal oils, or other herbal chemicals (ie: for cosmetics or medicines) it is likely that, to compete successfully, you will also have to undertake similar selection programs, and/or to produce oils or chemicals that are not already commonly produced. You may be lucky and be able to obtain some high yielding cultivars commercially, or from other growers, or from various government organisations (ie: Dept. of Agriculture). This will give you a real head start, but ideally further selection, using those cultivars as breeding stock is recommended. It is important to note that it is not only necessary to select high yielding cultivars, but also ones that are reasonably easy to grow.

For those who wish to grow a variety of herbs for culinary purposes, then selection programs are not as critical. For nursery production of herbs it is extremely important that the plants you are selling are correctly identified and labelled with their latin botanical names.

WHERE TO MARKET YOUR HERB PRODUCTS

- **Direct to retailers:** This involves a lot of chasing around to find retailers who would be interested in your product. It has the advantage of cutting out any middlemen, thereby increasing your profit potential.
- **Through wholesalers or brokers:** These have the advantage of having the expertise and contacts to distribute a wide variety of costs. It saves a lot of chasing around, but of course they want to make a profit so there is less profit than dealing direct.
- **Direct sales:** This enables you to sell directly from your property, or perhaps at markets or roadside stalls. This can often be inconvenient as it ties up your time, particularly on weekends when a lot of these types of sales occur. It does however, cut out the middle man thereby increasing your profit. This can be a good way to sell if you only have small quantities of produce to sell.
- **Mail Order:** This has proven very successful for 'long life' products., and ones that can be easily shipped without damage. Even potted plants have been successfully marketed this way. This method usually involves considerable advertising costs in comparison to the other methods.
- **On contract:** This can be direct to perhaps a supermarket chain or to a processing company. Supplying to a processing company means that you will not have to buy expensive processing equipment, but you will also not get the benefit of the value increase in the product after processing.

EXPORTING YOUR PRODUCE

Another market of increasing importance is the export market. It has been estimated that the U.S.A. imports over twenty billion dollars of herbal products per year (Herb Market Report Vol 5, No. 11). There is also increasing concern over the quality of home grown herbal products in Europe. Radioactive fallout from Chernobyl, widespread problems with air borne pollutants and contamination of water supplies, plus the increasing conversion of agricultural land to other uses has led to demand for herbal products from countries that are seen to be 'clean'. Australia is in an ideal situation to capitalise on this situation, in particular providing crops in off season times for the Northern Hemisphere. There is also a small but increasingly strong market for Australian herbs in Asia, particularly fresh culinary herbs.

The prime concerns for exporting crops from Australia is to select the right varieties and to maintain consistent supply and quality. Export agents or brokers are necessary to ensure that your produce is efficiently marketed.

Mentha villosa var Alopacuroides Boles

PRODUCTION REQUIREMENTS

Land

A successful herb farm could operate on as little as one hectare, or it may require up to a hundred or more hectares depending on the cropping system you are using and the types of plants you are growing. When aiming to buy land consider the following:

- **Slope:** Sloping sites often need expensive earth works or levelling before they are suitable for use. For some varieties, however sloping sites are ideal, particularly those that require good drainage.
- **Soil:** What is the soil like? Is it well structured, well drained, have good fertility and pH, free of pests, weeds and diseases, or other contaminants? Will it need extensive clearance of vegetation or stones?
- **Flooding:** Is the area prone to flooding?
- **Access:** Is there good access onto the property, through and around the property, and to markets and suppliers?
- **Existing facilities:** Does the property have existing facilities that can be utilised in producing your crop? Does the site have power and water either on site, or nearby were it can easily be connected?
- **Climate:** Is the climate suitable for the crops you wish to grow? Are their frost problems, high winds, bushfires, hail, etc?
- **Cost:** Are there cheaper alternatives? Can you really afford it? Don't forget that interest rates on loans may rise.

Equipment & Facilities

Do you have sufficient capital to buy the equipment and facilities needed to produce your crop? Do you have the expertise to use and maintain it?

At the very least you will need at least one small tractor and associated implements for soil working, pest and disease control, harvesting and transporting your produce from the field to the processing areas. A vehicle to transport you and your goods will also be required. You will also need a protected area to work in, and for processing your crop, as well as storage areas for supplies, equipment and harvested produce, and toilet facilities for you and your employees. You may have to pay to have electricity and water connected, or you may need to have pumping equipment installed to obtain water from a dam, bore, stream or irrigation channel. It is important also to have a good source of consumable supplies such as plant stock, fertilisers, pesticides, etc.

Labour

Sufficient labour is necessary at all times. You may have to arrange for seasonal labour needs (ie. during processing or harvesting). They must have sufficient expertise (including yourself) to produce a good quality crop, and to safely and efficiently operate any necessary equipment.

COSTING YOUR PRODUCTION

Introduction

A herb farm, like any business must set and adhere to certain standards if it is going to operate profitably. These standards can be broken down into three main groups...

A) Cost Efficiency Standards

B) Quality Standards

C) Size Standards

Cost Efficiency

There must be a sound relationship between cost of production and sales price. Both of these monetary figures must be constantly monitored and maintained at an acceptable level so as to ensure a profitability in the business.

Cost of Production + Profit = Sales Price

If the cost of production gets too high, then profit will decrease. In such a situation, the sales price must be increased, or else the profit figure can become a minus amount (ie. You might be losing money rather than making money).

In order to control your standard of cost effectiveness, you must understand (and control) all of those things which

influence Cost of Production. You may also need to make adjustments to your sales price figure in order to maintain an acceptable profit figure.

Cost of Production

The cost of production is influenced by the following factors:

- Cost of site including interest payments, or lease/rent value).
- Cost of equipment and facilities both to install and maintain.
- Cost of site services (Power, Gas, Water, etc).
- Cost of materials (fertilizers, pesticides, seed, etc).
- Cost of unsold produce...a certain proportion of stock may be lost, may die, or may just become too sick looking to be able to be sold.
- Labour costs (Be sure to include your own time as well as employees). Labour costs include not only direct wages, but also insurance costs, superannuation payments, holiday pay, sick leave costs, training costs, costs of safety equipment and/or uniforms, etc.
- Advertising/Promotion (Printing, advertising in magazines etc)
- Selling costs (Delivering, Invoicing, etc).
- Insurance costs such as public liability, house and property, vehicle, and damage to crops.
- Taxation (Don't forget Payroll tax, income tax, etc).

Profit

This figure should be over and above money which you earn as wages. If you are only working for wages (with no profit), then you would be better putting your money into some different form of investment and going to work for someone else. Profit should be greater than the interest rate which you could get by investing your money elsewhere. Profit should normally be at least 15 20%. If the business is only small, then the profit margin should be larger. If the business is large, then the profit per unit of produce (e.g. bunch of fresh herbs) can be kept lower. Profit in that situation comes through quantity of sales.

Sales Price

The figure which a plant is sold for can vary considerably. Retail price is often about twice wholesale price. This being the case, the wholesaler depends upon selling in large numbers in order to maintain profitability. Wholesale price varies considerably. Generally speaking this figure is largely affected by three things.

1. The producers reliability of supply. If you are well established and known to be a reliable source of goods, you can often ask a higher price.

2. Quality of plants offered. Higher prices are only paid for top quality stock.

3. The demand for that particular product. As demand increases prices will generally increase, particularly if supply of the particular product is restricted in some way.

Quality Standards

The following factors are of concern when considering quality of herbal products:

- General Health: pest or disease damage, dead leaves, burned leaves, markings on stems etc.
- Chemical content:herbal products sold for their chemical content may have minimum quantity standards of desirable chemicals and maximum standards for non-desirable chemicals.
- Uniformity: herb plants of a particular variety sold as nursery stock should be in the same sized pot, the same colour pot, the same type of label, etc. They should all be the same shape and size (roughly).
- Impurities: some products may have a maximum level set for impurities, in particular for products such as dried herbs.
- Age of product: use by dates may be applied to some products, particularly culinary and medicinal to ensure their freshness.

Size Standards

Many products will have minimum and/or maximum size standards apply. For example bunches of fresh herbs should be of a certain size or weight.

PRACTICAL EXERCISE

- Consider the formula:

  Cost of Production + Profit = Sales Price

- Plan the establishment of a new hypothetical herb farm which is to produce bunches of fresh culinary herbs for sale to local fruit and vegetable stores and restaurants.
- Set a sales price per bunch of herbs to be produced (Be realistic).

  Sales Price = ... per bunch

- Set a profit figure for the formula (probably 20 or 30% of sales price, depending on the scale of production).

  Profit =.....per bunch

- Calculate what your cost of production should be.

  Cost of Production (Per bunch) = ...

- On the basis of the cost of production you have set, prepare a simple budget for the first years operation of this herb farm Fill in costs below:

BUDGET

- Number of bunches to be produced in the first year.....
- Number of bunches to be thrown away (die, become diseased, get too woody etc) .....
- Number of bunches sold in first year .....
- Money generated through sales (Income) .....

Cost of Production

Property and Services	$.....
Materials	$.....
Pots	$.....
Soil	$.....
Fertilizer	$.....
Other chemicals	$.....
Stationary	$.....
Labor	$.....
Advertising/Promotion	$.....
Selling	$.....
Other?	$.....
	$.....
Total Operating Costs =	$.....
	$.....

Now consider how efficient your planned operation is.

- What things could you look at to increase your profitability?
- What costs might be reduced?

By thinking through these things you will develop your insight into more efficient business management.

HYPOTHETICAL CASE STUDY

- Consider the formula:

  Cost of Production + Profit = Sales Price

- Plan the establishment of a new hypothetical herb farm which is to produce bunches of fresh culinary herbs for sale to local fruit & vegetable stores and restaurants.
- Set a sales price per bunch of herbs to be produced (These figures are a little old and not that realistic - you will need to do this with more up to date figures).

  Sales Price = 90 cents per bunch

- Set a profit figure for the formula (probably 40 or 50% of sales price, depending on the scale of production).

  Profit = 45 cents per bunch

- Calculate what your cost of production should be.

  Cost of Production (Per bunch) = 45 cents

- On the basis of the cost of production you have set, prepare a simple budget for the first years operation of this herb farm.

Fill in costs below:

BUDGET

Number of bunches to be produced in the first year = 65,000

Number of bunches to be thrown away = 5,000 (These can be dried for extra income)

Number of bunches sold in first year = 60,000

Money generated through sales (Income) = $54,000

Cost of Production

Property and Services	$8,000
Materials	$3,000
Fertilizer	$3,000
Other chemicals	$800
Stationary	$400
Labor	$26,000
Transport/Marketing	$2,300
Vehicle Expenses	$5,300
Other (eg: insurance)	$1,200
Total Operating Costs	$50,000
Profit	$4,000

Are these figures realistic?How could each cost be lowered? Is the profit enough, or would you be better off investing elsewhere?

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Many of the above publications are available from the author, John Mason, through the ACS bookshop.

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OTHER BOOKS

Other books by the same author as this book, which may be of interest to gardeners in the tropics & subtropics include:

"Growing Ferns" by John Mason published by Kangaroo Press

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