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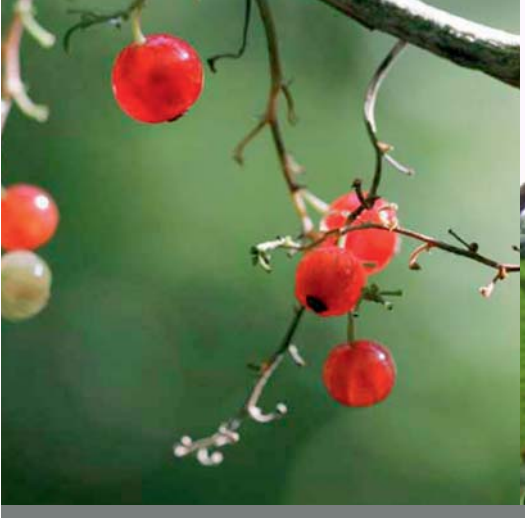
Creating a Forest Garden

Written by Martin Crawford

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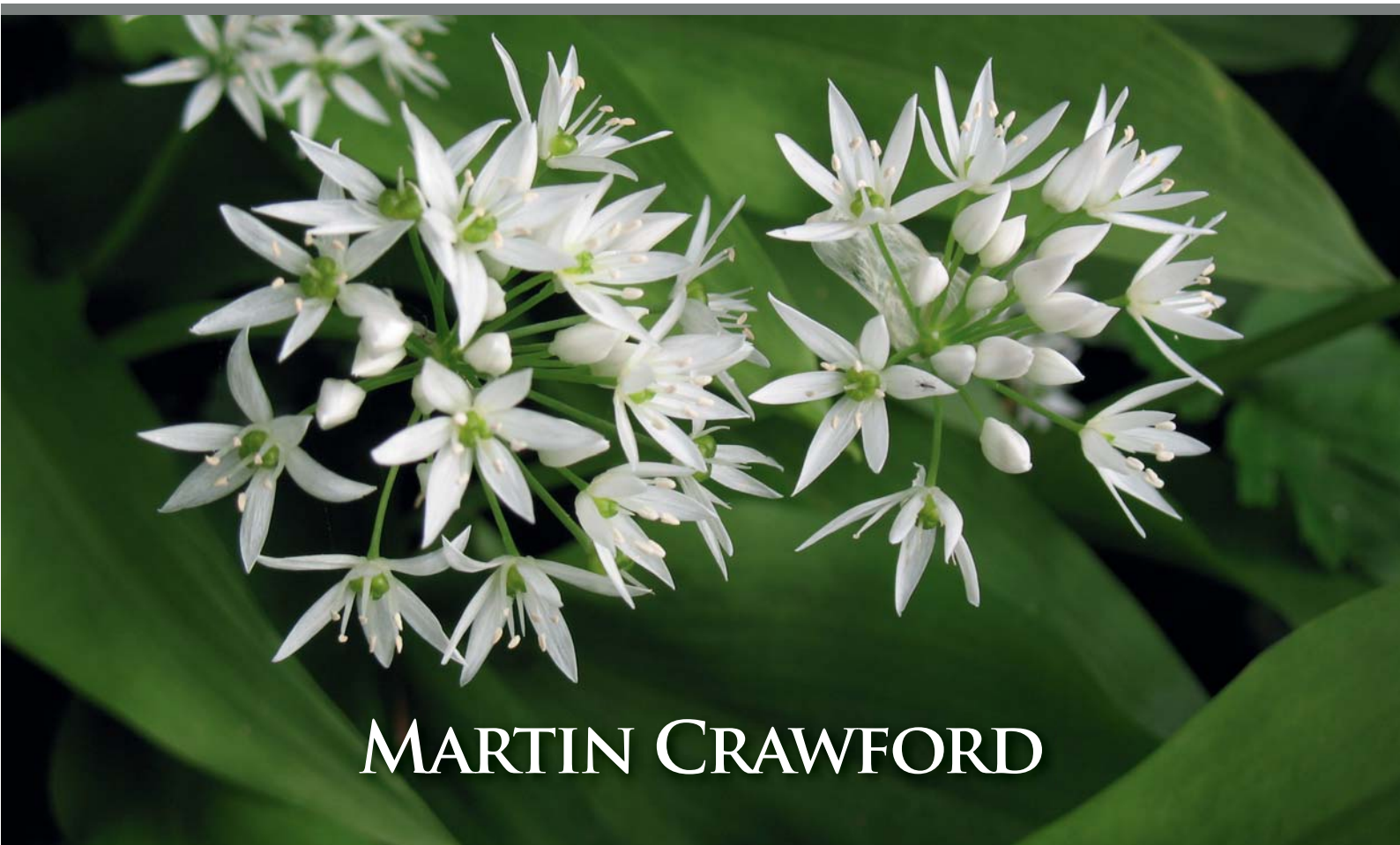
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Creating a Forest Garden

Working with Nature to Grow Edible Crops



Martin Crawford

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from the Foreword

In 1992, in the middle of my Permaculture Design Course, about twelve of us hopped on a bus for a day trip to Robert Hart's forest garden, at Wenlock Edge in Shropshire. A forest garden tour with Robert Hart was like a tour of Willy Wonka's chocolate factory with Mr Wonka himself. "Look at this!", "Try one of these!". There was something extraordinary about this garden. As you walked around it, an awareness dawned that what surrounded you was more than just a garden – it was like the garden that Alice in *Alice in Wonderland* can only see through the door she is too small to get through: a tangible taste of something altogether new and wonderful yet also instinctively familiar. This seeming riot of plants and trees, when explained, proved to be an intelligently designed, three-dimensional food system, based on perennial plants, which offered a whole new way of imagining agricultural systems.

Martin Crawford was one of those early visitors to Hart's forest garden, and since then has made the single most extraordinary contribution to our understanding of what makes a forest garden actually work. For many years, as a permaculture teacher, I have been in awe of Martin's work.

Chapter 1

Forest gardens

What is a forest garden?

A forest garden is a garden modelled on the structure of young natural woodland, utilising plants of direct and indirect benefit to people – often edible plants. It may contain large trees, small trees, shrubs, herbaceous perennials, annuals, root crops and climbers, all planted in such a way as to maximise positive interactions and minimise negative interactions, with fertility maintained largely or wholly by the plants themselves.

The plants in a forest garden are mainly perennial, which gives the system its long-term nature. Many of the plants used are multipurpose; they may have a main function or crop but will very often also have a number of other uses. Plants are also mixed to a large degree, so there are few large blocks or areas of a single species, and each species is grown close to many others in ways that are mutually beneficial.



Apricot and cordyline palm in my forest garden.

A forest garden is in fact a carefully designed and maintained ecosystem of useful plants (and perhaps animals too). The self-fertilising nature comes from the use of nitrogen-fixing plants and other plants that are particularly good at raising nutrients from the subsoil, and from the very efficient nutrient cycling that develops in a forest-like system. The soil is maintained in peak condition by being covered by plants at most times, and garden health is boosted by the use of plants that attract predators of likely pests, and plants that reduce disease problems. Diversity is important too: high diversity almost always increases ecosystem health.

The term 'forest garden' may imply something large and extensive, which is not necessarily the case – forest gardens can be cultivated on any scale, from a small back garden to a field, or several fields. 'Woodland garden' can sometimes be the same thing. Unfortunately, in our culture, 'forest' or 'woodland' implies a denser, darker collection of trees, which is not the case in a forest garden, as you'll see.

Although the history of forest gardens in the UK and North America is short – forest gardening in the UK has developed only in the last 25 years – there is a much longer history of two-storey systems of food production: for example, plum orchards with rows of soft fruit between; hazelnut orchards with alleys of vegetables between; and undergrazed orchards using large fruit trees.

In many parts of the world, forest gardens are called home gardens, for they adjoin or surround people's homes. Scientists call these gardens 'multistrata systems'. There are thousands of square miles of such gardens, particularly in tropical Asia and Africa, Central America and temperate and subtropical China.

In Chinese forest gardens, high timber trees such as poplar and elm are usually integrated with other crops



New shoots of greenwax golden bamboo (*Phyllostachys viridiglaucescens*).

Chapter 5

Emulating forest conditions

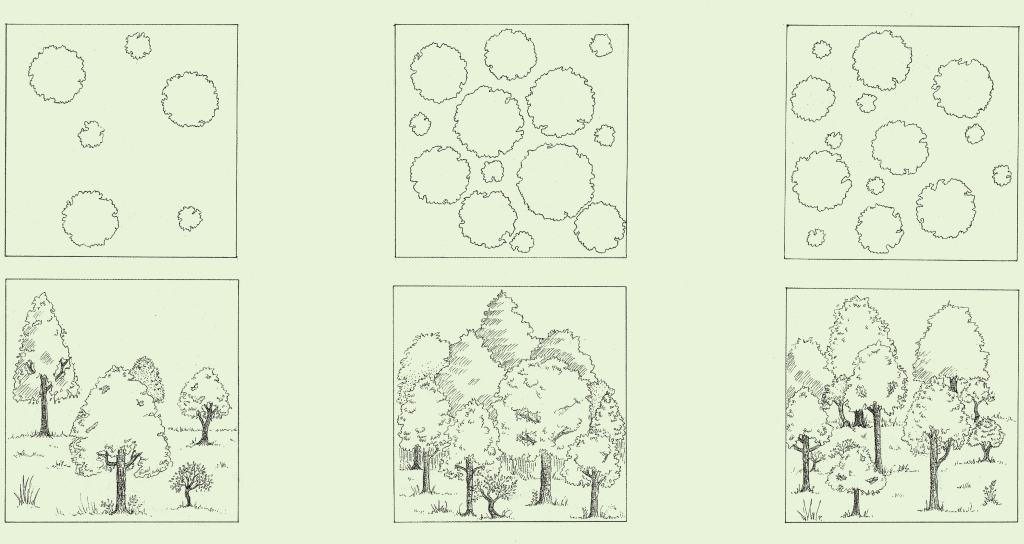
It is worth looking at how conditions are different within forests (compared with open gardens) before starting to design a garden, as this can give lots of clues and ideas about what sorts of plants will be happy where.

Shade

The amount of shade beneath a forest canopy is the most limiting factor for lower plants. In a closed-canopy forest (where the canopies of large trees are touching and there are few gaps letting light through), very little light energy reaches the ground in temperate latitudes, and few productive and useful plants can be grown. This is why I emphasise that a temperate forest garden is not a closed-canopy forest; it is more like a young establishing forest where there are plenty of gaps between trees and shrubs to allow light in. This is one of the main differences between temperate and tropical forest gardens – in tropical regions there may be eight times as much sun energy, and even below a fairly closed canopy there is enough energy to grow many other crops.

Under a closed deciduous canopy, most plant growth below the trees occurs in spring, before the trees are fully in leaf, with very little growth occurring in summer and autumn. This can often be seen in natural forests, where for example there may be an explosion of growth of bluebells, wild garlic and other bulbs in late winter and spring, which can virtually vanish by late summer.

The shade experienced by lower plants is mainly controlled by the density of the tree canopy above – which is largely controlled by the tree spacing, and also by the density of foliage in individual trees. Trees such as rowan (*Sorbus aucuparia*), black locust (*Robinia pseudoacacia*)



Different tree densities control the shade beneath and determine what can be grown there.

Chapter 6

Fertility in forest gardens

Natural forests do not need feeding – that is obvious. They just grow: trees flower and fruit, and smaller plants usually survive any browsing damage from insects and animals.

In fact natural forests do get inputs of nutrients, notably nitrogen. These come from a variety of sources – bird and animal droppings, soil-dwelling nitrogen-fixing bacteria, nitrogen-fixing plants (in a woody situation these are usually trees and shrubs), and atmospheric deposition of nitrogen – this is greater where there is pollution with chemicals such as oxides of nitrogen from burning fossil fuels. Sustainable sources of all plant nutrients also come from natural mineralisation processes of rock and soil, greatly aided by fungi.

Forest gardens may be modelled on natural young forests, but we usually want a greater yield from them than that available from natural forests, and that means we have to plan for feeding certain plants with extra nutrients to replace those harvested.

Different plants need different nutrients

The types of plant in a forest garden can be divided into four groups, according to their demands for nutrients.

- Undemanding, lightly cropping unimproved fruits, e.g. hawthorn, and lightly cropping perennials.
- Moderately cropping fruiting plants, e.g. currants.
- Heavily fruiting plants, e.g. chestnuts or hazelnuts.
- Annual vegetables. These require very high fertility to yield the kinds of crops we expect from them. These species have been bred over many years to respond to high levels of nitrogen and potassium.

Nitrogen

The best way to supply nitrogen into a forest garden system is by the use of nitrogen-fixing plants. By using these plants, which in a forest garden are mostly trees

NITROGEN SUPPLY TO SUSTAIN CROPPING				
Supply of nitrogen	**Nitrogen (N) content**	**Annual requirement**		
		Moderate croppers: 2g/m². Amount of N supply per m² =	**Heavy croppers: 8g/m². Amount of N supply per m² =**	**Annual vegetables: 28g/m². Amount of N supply per m² =**
Nitrogen fixer in full light	10g/m²	0.2m²	0.8m²	3m²
Nitrogen fixer in part shade	5g/m²	0.4m²	1.6m²	6m²
Human urine	5.6g/pee	½ pee	1½ pees	5 pees
Manure	6g/kg	0.3kg	1.3kg	4.5kg
Compost	5g/kg	0.4kg	1.6kg	5.5kg
Comfrey mulch (single cut)	0.5g per cut	4 cut plants	16 cut plants	60 cut plants
Fresh seaweed	2g/kg	1kg	4kg	14kg

Chapter 8

Growing your own plants

Most folk thinking about making a forest garden will already be growing some of their own plants. Growing plants is fun and interesting – even more so for trees, shrubs and herbaceous perennials, which most people do not start off themselves. Seed is relatively cheap, and some of the rarer species may be available only as seed.

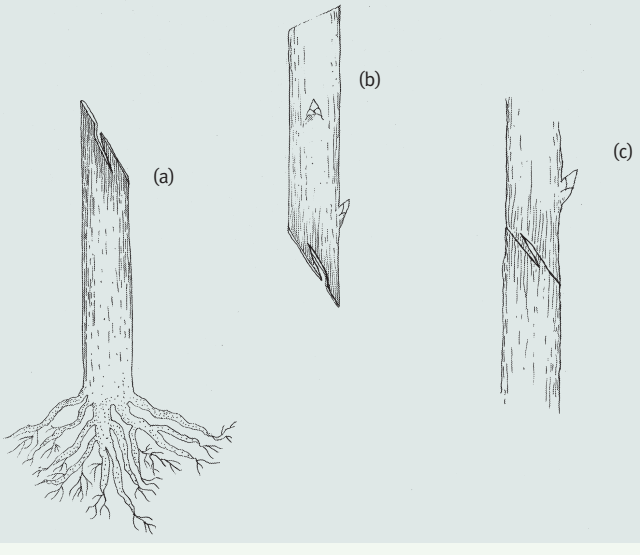
Seed-grown plants are almost always genetically different from their parents. This can be a good and a bad thing. Genetic diversity is generally good for a plant. However, if we want a good fruiting tree then this cannot be guaranteed by growing a seed from a good fruiting tree; what you get depends very much on the genetics of the tree and how highly bred it has been.

With apples, for example, they have been so highly bred with back crosses of various different crab species for disease resistance, etc. that the chances of getting a tree from seed with fruit as nice as the mother tree is quite small and not really worth trying unless you are prepared to grow thousands of seedlings. You are better off buying a grafted tree of a known variety.

With a species such as heartnut (*Juglans ailantifolia cordiformis*), however, about half of the seedlings from a good fruiting tree will have fruits (nuts) as good, or better, than the mother tree, so it makes much more sense to use the seeds to grow your own trees.

Grafting trees and shrubs

Grafting fruit trees is a long-established method of propagating true-to-name varieties. Amongst other things, it means that rootstocks of different vigour can be selected to grow trees of different sizes. It is possible to grow some varieties of apples and plums on their own roots (usually by air layering) – and own-rooted fruit trees are claimed to be healthier, longer-lived and have tastier fruit than grafted trees. However, there are some



Whip-and-tongue graft

(a) The rootstock with whip and tongue cuts.
(b) The scion with cuts.
(c) The graft fitted together ready for binding.



Juneberry (*Amelanchier lamarckii*) 'Ballerina'.

Chapter 11

Canopy species

By 'canopy species' I don't necessarily mean large trees. In a wild forest, the canopy does tend to be large trees, but in a forest garden the canopy may be 3m (10') high in some places, and consist of shrubs and not trees, so in this chapter I include both trees and large shrubs. Some of the same species may appear in the understorey shrub / small-tree layer, beneath larger trees.

Less-common fruiting trees

There are some fantastic lesser-known trees with great edible fruits. Some you may well have seen in ornamental gardens, where their fruits are admired but never eaten!



The forest garden in early summer.

Snowbell tree (*Halesia carolina*) showing the young fruits.



Halesia carolina, SNOWBELL TREE

Deciduous/Evergreen: D Zone: 5
Sun/shade preference: ○
Shade tolerance: ◑
Performance rating: ✓✓✓✓
Fertility: SF

An almost-unknown tree in Europe, this tree of American moist woods produces a really good crop of young crunchy fruits with a cucumber/pea-like flavour – great in salads or pickles.

Size: In the UK, 3-4m (10-13') high and wide in time, but slow-growing and bushy.
Conditions: Unfussy, but prefers sun.
Flowering: Mid-spring, with white flowers in profusion – very ornamental.
Fruiting: Starts after 3-4 years. The fruits are four-winged, green and 2-3cm (0.8-1.2") long. They are ready to eat from late June for 3 weeks or so.
Harvest and storage: Pick green fruits as soon as they

are large enough – 1cm+ (0.4"+). Use quickly.
Cooking/processing: They need only light cooking for a few minutes.
Secondary uses: A good bee plant. Flowers are edible in salads too.
Propagation: By seed (needs 3 months' stratification).
Maintenance: None needed.

Sea buckthorn (*Hippophae rhamnoides*) 'Leikora'.



Hippophae spp., SEA BUCKTHORNS

Deciduous/Evergreen: D Zone: 3
Sun/shade preference: ○
Shade tolerance: ◑
Performance rating: ✓✓✓✓
Fertility: MF

Species include *Hippophae rhamnoides* (sea buckthorn) and *H. salicifolia* (Himalayan or willow-leaved sea buckthorn). They originate from well-drained open sites. *H. salicifolia* is less hardy, to zone 6-7.

Size: *H. rhamnoides*: 3-4m (10-13') high by 5m+ (16'+) wide, sometimes lower.
H. salicifolia: 10m (33') high by 6-8m (20-26') wide.
Conditions: Well-drained soil and full sun; tolerates exposure.
Flowering: Spring, tolerant of frosts.
Fruiting: Starts in 2-3 years. Fruits are round or oval, 8-15mm (0.3-0.6") long, orange, juicy and borne in clusters close to stems.
Uses: Fruits are eaten, usually cooked or processed. They are acid when raw.
Harvest and storage: Pick when fruits colour and soften in late summer. They are borne close to the branches and usually have to be hand-picked – a messy business as some fruits burst and cover your hands in juice. Alternatively, cut off heavily fruiting branches (a kind of coppicing), cut them into sections and freeze in a freezer; once frozen, the fruits knock off easily. They don't keep for long.
Cooking/processing: Lightly cook the fruits and put through a Moulinex sieve to get a pulp. This can then be used to make a fine jam or mixed with other fruit pulps to make leathers.
Secondary uses: Good bee plant and nitrogen fixer. Good for hedging.
Propagation: Hardwood cuttings for named selections.
Maintenance: The main disadvantage with *H. rhamnoides* is that it suckers vigorously and will require management to stop it going where you don't want it. *H. salicifolia* suckers less but the fruits are not so easy to harvest.
Cultivars: Good fruiting selections (and males) have been made from *H. rhamnoides*:

Females:	***Males:***
Frugna	Polmix
Hergo	Romeo
Leikora	
Orange Energy	

Morus spp., MULBERRIES

Deciduous/Evergreen: D Zone: 5
Sun/shade preference: ○
Shade tolerance: ◑
Performance rating: ✓✓✓
Fertility: SF

Mulberry species include *Morus nigra* (black mulberry), *M. alba* (white mulberry), *M. rubra* (red mulberry) and their hybrids. They are great fruiting trees, reliable and with wonderful fruits: no forest garden should be without one (at least)! In addition, the leaves can be cooked and eaten – in parts of the Mediterranean they are used like vine leaves to wrap parcels of food. In the UK, you need to protect very young trees from snails and slugs, which like to graze on the bark. Mulberry is one of the latest trees to leaf out. Fruits ripen over several weeks in August and September; birds make take some.

Size: 5-10m (16-33') high and wide, but can be kept smaller by pruning.
Conditions: Unfussy as to soil; needs some sun and shelter (branches are brittle).

Chapter 12

Designing the canopy layer

I regard the canopy layer design as the single most important part of the design of a forest garden. Tree density is critical when you are trying to grow other crops beneath the tree canopy. It is easy to mistakenly plant too densely, because tiny trees look insignificant and there appears to be loads of space between them.

Having said that, don't be worried about making a few mistakes in the canopy design. Nothing is set in stone – if you find in time that you have planted too densely in one area, you can always remove a few trees to rectify the situation.

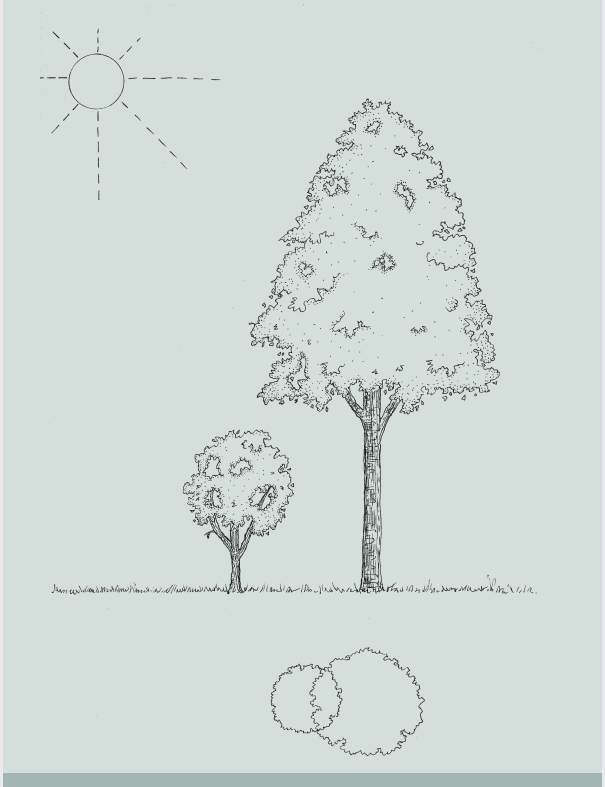
I would advise you always to do the planning of the canopy layer on paper, using a scale plan of your garden site. Use the map you made as described in Chapter 9, page 62, at a scale of 1:100 or 1:200.

You need to have come up with a list of trees you want for the canopy layer. This will depend on your preferences for types of crop, etc., and a wide range of trees is possible, as described in Chapter 11. However, you probably won't know whether you have too many, too few or about the right number of trees for this layer until you start the design process described below. As a rough rule of thumb, you'll have room for about one tree per 20-40m² of garden – the lesser area in smaller gardens and the greater in larger gardens. But in the design process you can always add or take away trees as appropriate.

Canopy tree spacing and canopy profile

In general, don't plant canopy trees closer than their maximum potential width allows. You don't want many canopies touching each other or intermingling, because they will cause deep shade beneath and any rubbing branches can aid the spread of diseases.

However, because the forest garden is growing in three dimensions, it is possible on a plan view to have canopies overlapping, while in reality they are at different heights. So, for example, in my forest garden I quite often have tall Italian alders (*Alnus cordata*), high-pruned so they have a clean trunk of 7-8m, with a fruiting tree to the south and partially beneath the alder canopy. Because of the orientation, the fruit tree loses almost no light as a result of the alder, yet it gains from extra frost and wind protection and benefits from the extra nitrogen in the alder leaves and roots.



Italian alder with a fruit tree. The tree can be tucked under the alder canopy on the southern side.



New leaves and flowers of Californian bayberry (*Myrica californica*).

Chapter 13

Shrub species

The shrubs described here vary from small upright species to those growing 3m (10') high or so. Some of these latter larger shrubs may of course serve as the canopy species in some forest gardens. Also, some trees may in fact be treated as shrubs, if they are heavily pruned or coppiced – for example, lime trees (*Tilia* spp.) and Chinese cedar trees (*Toona sinensis*), and so may appear in the shrub layer rather than the tree layer in a garden.

Common fruiting shrubs

Most people will know some or all of these plants, and perhaps have some in their gardens already. It is worth noting that productive and disease-resistant varieties should be chosen at the outset rather than risking unknown free materials from friends!

DWARF FRUIT TREES

For details of fruit trees see Chapter 11, Canopy species. I don't generally recommend really dwarf fruit trees (in fact shrubs) for forest gardens because they are more prone to diseases and suffer easily from competition. However, on occasion apples on rootstocks, such as M27 and M9 (growing 1.5m/5' and 2m/6'6") high respectively) might be suitable.



Redcurrant (*Ribes rubrum*).

Blackcurrant (*Ribes nigrum*).



Ribes nigrum, BLACKCURRANT

Deciduous/Evergreen: D Zone: 5
Sun/shade preference: ○
Shade tolerance: ◑
Performance rating: ✓✓✓✓
Fertility: SF

Most British gardeners know and love this plant and the strong-flavoured black fruits it bears. Reliable and easy to grow, blackcurrant gets planted in most forest gardens, where it forms a stooling multistemmed shrub.

Size: Up to 2m (6'6") high by 1m (3') wide.
Conditions: Tolerates most soils and light shade. Fruiting falls off in more shade.
Flowering: Mid-spring; pollinated by bees. Moderately frost-resistant.
Fruiting: Between mid-June and mid-September, depending on variety. Bushes crop for 15-20 years.
Uses: Fresh fruit, jams, fruit leathers, sauces (e.g. great with yoghurt, cooked pies, etc.).
Harvest and storage: Crops well, up to 4kg (9lb) per



Chinese dogwood (*Cornus kousa* var. *chinensis*) in full flower.

Chapter 22

Harvesting and preserving

Once a forest garden is established, you might find that, because maintenance is so minimal, harvesting takes most of the time you spend in the garden. How much time you spend harvesting of course depends on your garden, and every one is different. Many of the techniques and tips in this section are not unique to forest gardens, though of course some are.

This chapter does not aim to give a complete guide to food preserving techniques – there are plenty of other books which cover that in detail – but I do pay particular attention to food drying, which is still rare in the UK and deserves to be better understood.

Food plants

Most forest gardens have a preponderance of food plants, both for fresh eating and for storage.

Salad crops

Picking a forest garden salad is much more interesting than going to a veg patch and picking a lettuce. It can also take more time, depending on the number of ingredients you want. To pick a 20-ingredient salad from my forest garden takes about 40 minutes (2 minutes per person-portion.

When I am picking a salad I tend to think in terms of 'base' ingredients (which are usually mild in flavour and you can pick in bulk) and more flavourful 'aromatic' ingredients. I try to have at least two or three base ingredients and a dozen or more aromatics. I also always try to pick two or more types of flower, either to go into the mix or be sprinkled on top of the mixed salad for decoration.

Larger leaves I usually chop, while smaller ones can be left whole. A mixed forest garden salad is more than just the sum of its parts. It takes on a character of its own, with mild ingredients 'pepped up' and very strong ingredients diluted down. I rarely bother to put in more than about 30 ingredients, though my friend and fellow forest gardener Justin West has made salads with over 100 ingredients at the Schumacher College in Dartington.

Preserving raw leafy crops is not usually a high priority in climates where leafy crops are available all through the winter. Some options are to preserve in oils, e.g. make a pesto; or to preserve in lactic acid via wild fermentation (the process that makes sauerkraut.)

Perennial vegetables

It is often best to grow patches or drifts of one species of perennial vegetable to make a larger contiguous area, rather than dot them around here and there, to make harvesting that much quicker and more efficient (single plants of most perennial vegetables do not provide enough crop in a picking, so you need to crop several plants.)

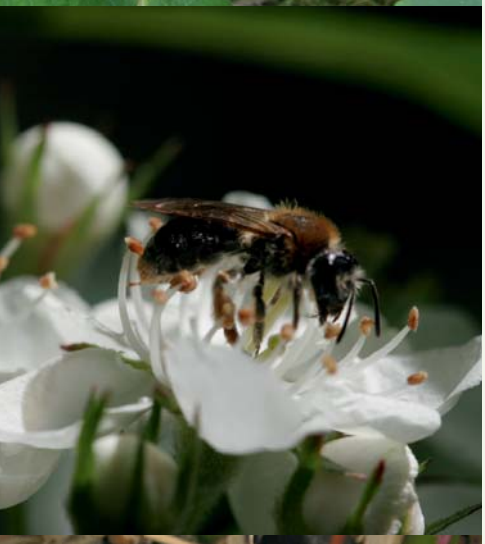
The plants themselves will often determine what you eat when. Bamboo shoots, for instance, have to be picked within days of appearing otherwise it is too late. You'll soon learn what is ready when – but it is a learning process, because many of the perennial vegetables will be unfamiliar.

All the usual preservation techniques for annual vegetables can be used, e.g. blanching and freezing, chutneys and pickles, lactic acid preservation (as above), etc.

Tubers

In a temperate climate where the ground does not freeze too much in winter, and does not get waterlogged, the best place to store tubers is usually in the ground. Where winter temperatures do get colder then dig tubers (e.g. yams, *Dioscorea* spp.) in autumn and store in sand, compost, etc. in a cool place or in a root cellar. Replant







"Martin is a true pioneer and his work deserves respect and celebration." ***Permaculture*** **magazine**

Growing food sustainably is becoming more and more important in the light of our changing climate. Forest gardening is a way of working with nature that is not only productive and low-maintenance but also has great environmental benefits. A forest garden is a managed ecosystem modelled on the structure of young natural woodland, with a diversity of crops grown in different vertical layers. Unlike in a conventional garden, nature does most of the work for you.

Creating a Forest Garden tells you everything you need to know – whether you want to plant a small area in your back garden or develop a larger plot. It Includes advice on planning, design (using permaculture principles), planting and maintenance, and a comprehensive directory of over 450 trees, shrubs, herbaceous perennials, annuals, root crops and climbers – almost all of them edible and many very unusual.

As well as more conventional plants you can grow your own Nepalese raspberries, chokeberries, goji berries, almonds and hops – while creating a beautiful environment that benefits you and the ecosystem. Forest gardens offer one solution for a long-term, sustainable way of growing food without compromising soil quality, food quality or biodiversity.



The author: Martin Crawford has spent over 20 years in organic agriculture and horticulture and is director of The Agroforestry Research Trust, a non-profit-making charity that researches into temperate agroforestry and all aspects of plant cropping and uses, with a focus on tree, shrub and perennial crops. It produces several publications and a quarterly journal, and sells plants and seeds. See www.agroforestry.co.uk for more information.

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