for the Gardener

Center for Agroecology & Sustainable Food Systems, UC Santa Cruz

Apple Trees for Every Garden

Orin Martin manages the Center's Alan Chadwick Garden and trains students in organic gardening. Fascinated by apple trees, he's made a study of rootstocks, varieties, and training and pruning systems that can be tailored to the backyard garden. Here he shares his knowledge of semidwarf and dwarf rootstocks, and the care required for growing these trees.

If your image of an apple tree includes a tire swing and a picking ladder, you may be surprised to find that rootstock breeding efforts have trimmed this popular fruit tree down to a more manageable size. "Mini trees" grown on semi-dwarfing and dwarfing rootstocks enable gardeners to plant a small orchard in almost any yard. And you won't have to wait long to harvest the first crop—if given proper care, these smaller trees will bear fruit within two to three years of planting, compared to the five or more years a standard-size tree requires.

Although a relatively new trend in the U.S., the "pedestrian orchard," where all tree work can be done without ladders, has been popular in Europe for decades. Over the past forty years, European commercial growers have made the transition from orchards that featured large, open-centered trees, less than 200 trees per acre, high labor inputs, and delayed cropping, to more intensive models. These new orchards feature planting schemes with as many as 1,300 trees per acre, extremely dwarfing rootstocks, and an emphasis on tree training over tree pruning. The results are orchards that come into bearing within two to three years of planting, include compact trees measuring 8–12 feet high, have substantially lower labor costs (since ladder work is eliminated), outyield traditional planting schemes, and produce high-quality fruit.

This approach to dwarfing trees dates back to the Greeks of the 3rd century B.C., and even earlier on the eastern rim of the Mediterranean Basin. In Northern Europe (principally France), dwarf deciduous fruit growing was a refined art by the 16th century. English horticultural writings of the 19th century reveal an interest in and knowledge of dwarfing rootstocks by both amateurs and commercial growers throughout Europe. Much of the theory and even some of the plant material being used in modern intensive orcharding has its roots in antiquity.

GREATER VARIETY POSSIBLE

The possibilities and advantages of growing dwarf apples for the home gardener abound. By keeping trees to a height of 7–10 feet at maturity, all the necessary tasks can be performed from the ground or on short ladders—observation and enjoyment, pruning/training, spraying, thinning, and picking. This makes for less and safer labor.

By growing smaller trees, home gardeners can get more out of a limited space. Gardeners can also pay more attention to seasonality—by having five 8-foot tall trees in a space previously occupied by one 20-foot tree, the home orchardist can select varieties that will produce apples for nearly year-round use: harvesting Lodi or Yellow Transparent as early as the 4th of July, Gravenstein and Chehalis in August and early September, Mutsu and Fuji in late September and October, and any of the pippin types for late fall picking (the Hauer Pippin can hang on the tree into December).

Along with the seasonal progression of apple varieties comes the taste-treat progression. Early ripening varieties are sweet but don't store well, mid season fruits offer a balanced blend of sugars and acids, and late, tart apples feature good cooking, juicing, and keeping qualities. It's possible to store some of the late pippin and russeted varieties into the spring in a cold room or cellar.

ROOTSTOCK OPTIONS

Your choice of rootstock is perhaps the most dominant and critical factor influencing the type of tree you'll end up with. In the world of apples, there is more sophistication and variety as per rootstocks (see chart, page 2) than with any other tree fruit. Dwarfing rootstocks control overall tree size by reducing shoot growth in the scion (upper, bearing part of the tree). Size-controlling rootstocks, rather than exclusively pruning, are an easier, more effective way to control a tree's height and keep it within its allotted space.

Dwarfing rootstocks also impart "precocity" to trees. That is, much like Mozart was a precocious lad and produced sonatas at the age of 3 or 4, the more dwarfing rootstocks you choose (M27, Mark, M9, M26), the earlier the tree enters its fruiting phase. Dwarfing rootstocks also impart more efficient productivity at maturity by contributing a better balance between vegetative and fruiting wood.

There are several drawbacks to dwarfing rootstocks. They often have brittle, restricted root systems that are unevenly distributed around the tree. This can result in inefficient water and nutrient uptake, thus stunting the tree. These poorly anchored root systems can cause the tree to lean or topple over when it's bearing a heavy fruit load in wet soils and windy conditions. While it is somewhat labor intensive, freestanding trees can be supported with an 8'–10' metal or wooden pole. Any rootstock more dwarfing than M26 must be supported.

Care should be taken to fertilize and water dwarf trees more frequently than standard-sized trees to encourage vigorous growth and to overcome lack of tree vigor induced by rootstock. Similarly, flowers and/or fruit should be removed the first 1–3 years, until the tree has established itself. Fruit set on a young tree competes for available nutrients and reduces vegetative growth.

TREE QUALITY

It is important to purchase vigorous, well-grown nursery trees. The two basic options are whips and cut, or branched, trees. A whip is a one-year-old tree with a central trunk but no branches. A branched tree is usually a one- or two-year-old tree that has been trained in the nursery and has lower tier branches already formed. Often it is a taller tree with a greater trunk size (caliper) than a whip, and has a correspondingly bigger root system.

The more branches—and thus leaf surface area—a tree has, the more quickly it will grow and come into bearing. Also, studies have shown that trunk size at planting is related to tree vigor and productivity throughout the life of the tree. In essence, bigger trees perform better—both early and in the long run.

PLANTING AND FERTILITY

When preparing the planting hole, make it slightly wider and deeper than the spread-out roots. Although conventional wisdom dictates that fertilizer shouldn't be added to the planting hole, that information is based on mechanized hole digging and large-scale planting, and doesn't necessarily apply to a backyard garden. However, don't add more than 10%–20% ***stabilized, finished*** compost mixed in with the soil that comes out of the planting hole—otherwise you may get a "pot effect" in the hole, and the roots will be reluctant to extend into the surrounding soil. Uncomposted organic matter or too much organic matter added to the soil can also cause problems, e.g., the soil in the hole may dry out more quickly than the surrounding soil. To encourage roots to lengthen and deepen, work the soil outside the tree's drip line with cover crops and soil amendments, such as finished compost.

Place the bud union (the point where the scion is budded or grafted onto the rootstock), which appears as a visible swelling, 2"–3" above the soil. The bud union scar should face north or away from the prevailing wind. In hot areas, the trunk should be whitewashed to protect it from sun damage until a canopy of leaves is in place.

Smaller trees with restricted root systems need consistent watering. During the dry season, check every two to four weeks to make sure the soil around the root system is moist at least a foot deep.

Rootstock Types and Characteristics

Type	Height	Other Characteristics and Features
Semidwarfing		
MM 111	15–20 feet	Adapted to a variety of soil conditions; tolerates drought. Rootstock has fibrous roots—produces a heavy-bearing, well-anchored tree. Excellent for spur-type cultivars.
M 106	14–18 feet	Adapted to a wide range of soil temperatures. Should not be planted on poorly drained soils
M 7	11–16 feet	One of the most popular rootstocks. Exceptional winter hardiness; performs best on deep, fertile, well-drained soils that retain constant moisture. Susceptible to woolly apple aphid; moderately resistant to fire blight. May lean with heavy crops on windy sites—advisable on such sites to support lower trunk to a height of 3' in early years.
Dwarfing		
M 26	8–14 feet	Roots well and better anchored than M9, though still needs support. Very productive and early bearing; recommended for use on all but badly drained soils. Rather shallow-rooted—careful attention must be paid to irrigation management.
M 9	8–12 feet	Very precocious with high yield efficiency; susceptible to fire blight and woolly apple aphid. Most extensively planted rootstock worldwide.
Mark	8–10 feet	Very precocious with high yield efficiency. Trees on Mark require support to produce a full-canopied tree. Extremely hardy, tolerates numerous soil types. More resistant to fire blight than M 26. Heavy bearing in early years stunts tree—thin fruit to avoid.
Extremely Dwarfing		
M 27	4–6 feet	Very precocious with high yield efficiency. Requires support. Less susceptible to fire blight than M 9 and M 26. Well suited for growing in a container or a small yard. Fruit should be thinned or removed for the first year or two to encourage growth. Very exacting—requires frequent inputs of water and nutrients because of restricted root system.

The goal for the first few years of the tree's life is to generate two to four feet of extension growth per year, rather than try to maximize cropping too early. Establishing the tree's framework of branches will ensure a good return on your investment.

PRUNING AND TRAINING

The general goal of dormant winter pruning is to create a relatively permanent branch structure on which fruit is borne. Careful pruning also allows easy access to the tree for all operations (thinning, picking, etc.), and encourages air to circulate and sunlight to penetrate into the center of the tree canopy. Good air circulation minimizes disease, especially mildew. Sunlight contributes to high fruit quality and color, and is essential for fruit spur development and fruiting.

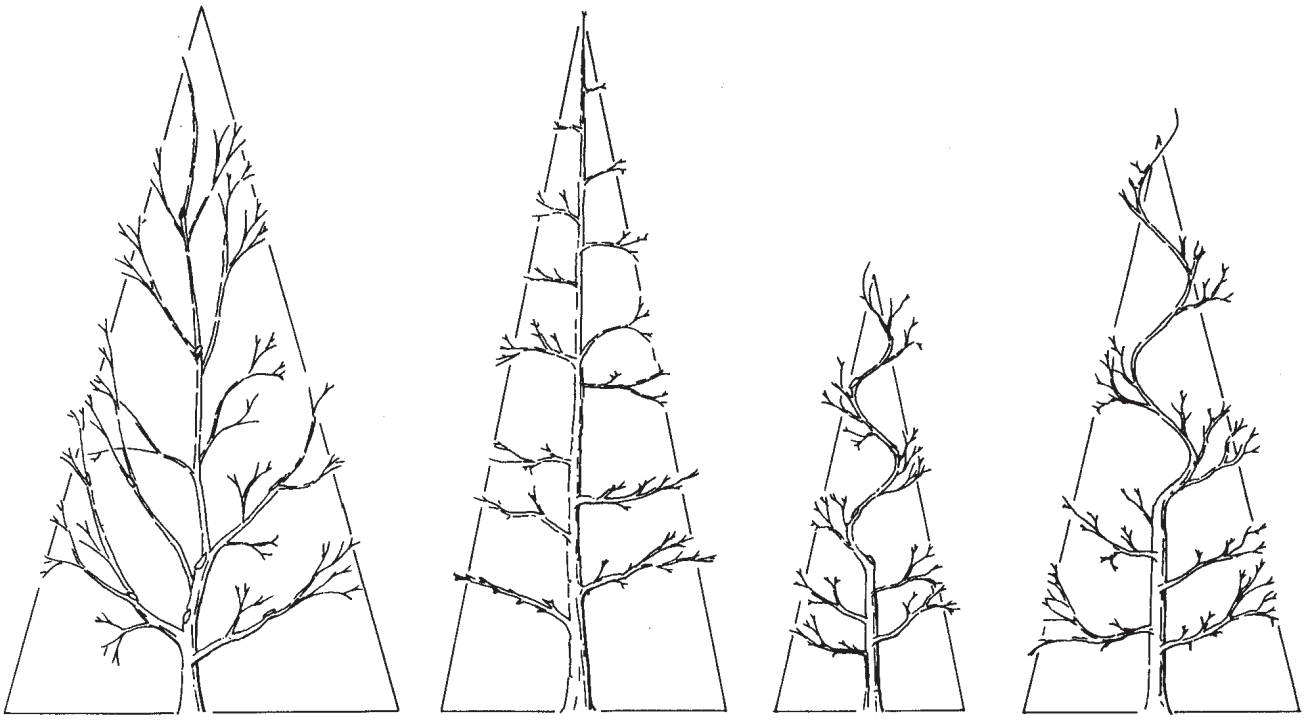
Always prune with a plan and a clear sense of the intended tree form. Prune as little as possible—it's better to under prune than to over prune. Excessive pruning begets an overly vigorous growth response, keeping a tree from its fruiting phase. The removal of a branch equals the removal of stored carbohydrates, as well as photosynthetic surface (leaves), and it's the accumulation of carbohydrates that contributes to fruit development. Planting a large, branched tree combined with minimal pruning in the early years leads to early fruit production.

With young trees, the goal of pruning is to shape and establish tree form and structure. As trees mature, the goals of pruning are to control tree height, allow sunlight and air to circulate into the center of the canopy, remove poorly placed branches, and renew older branches.

There are two basic types of pruning cuts: thinning cuts are used to remove a branch in its entirety. If properly done, there should be no regrowth. Heading cuts refer to cutting back the length of a branch—the result is to stimulate growth at the point of cutting. Typically, the topmost bud below the cut will assume apical dominance and resume growth. The harder the branch is cut back (into one-year old wood), the more vigorous the growth response in the next growing season.

A secondary effect of a heading cut is lateral branching at the next two or three buds below the lead bud. It is primarily on these moderately strong lateral branches that fruit spurs and eventually apples will form.

The best way to achieve the above goals on apple trees is to grow a large caliper (1/2"–3/4") branched tree on a dwarfing rootstock (M27, Mark, M9, M26, M7) in one of several training systems: the modified central leader, slender spindle, vertical or French axe, and hybrid tree cone or "Hytec" (see illustration, below). All of these training/pruning systems feature a vertical axis or central trunk with tiers of horizontal scaffold (fruit-bearing) branches radiating out. The overall shape of the tree is much like the silhouette of a Christmas tree. The overall height varies from 7–14 feet, depending on rootstock, variety, vigor, training system, and the tree's interaction with soil, climate, water, nutrients, and other factors.



Four training/pruning systems (l-r): modified central leader, French or vertical axe, slender spindle, and Hytec.

THE MODIFIED CENTRAL LEADER ("HEAD AND SPREAD")

Features:

- Tree Height—8′–14′
- Spread at Base—8′–10′
- Space between Trees—6′–10′
- Tree Density—200–600 trees/acre
- Rootstocks—Mark, M26, M7, M106, M111
- Support —None, except possibly on Mark
- Labor Needs—High
- Cropping—Low 3–5 yrs, moderate 5–10 yrs, moderate/high >10 yrs

This has been the standard training system in the U.S. for the past 20-30 years. The modified central leader (MCL) system results in large, free-standing trees with a dominant central leader off of which radiate whorls or tiers of horizontal branches at two or three levels along the length of the leader (see illustration). The aim of this system is to create two or three whorls of horizontal scaffold branches over the 12′–14′ vertical run of the trunk, or one continuous whorl over that same run. The positioning of the tiers should be: 5–7 branches at 2–4 feet, a second whorl of 3–5 branches at 6–8 feet, and a third whorl of 2–3 branches at 10–12 feet.

The lower limbs are positioned at 30°–45° above horizontal and are headed back annually (dormant season) by 1/4–1/2 the previous season's growth. This angle of positioning along with heading back strikes a balance between forcing lateral fruit-bearing branches and continued vegetative extension growth. When these limbs have filled their allotted space (3–5 years) they are pruned back to a weak lateral with a shortening cut into two-year-old wood. Pruning into older wood stops a tree, while pruning into one-year-old wood stimulates growth.

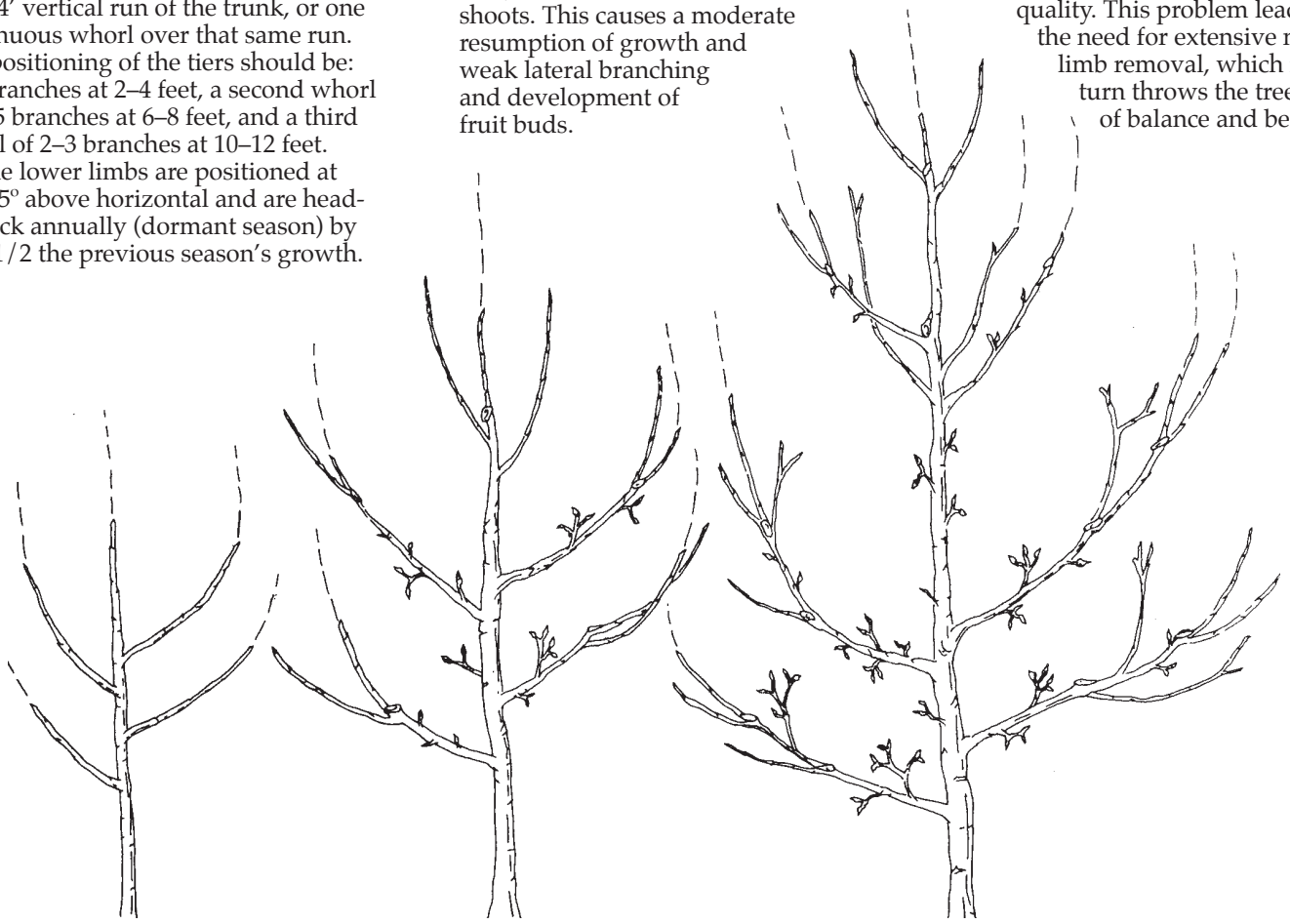
The lateral branches that develop on the horizontal scaffold branches must be managed for control of excessive vigor and to develop fruit wood. This can be done by—

- thinning out any upright, overly vigorous shoots.
- training or tying down moderately vigorous shoots. Bending a limb from vertical to horizontal causes growth to weaken and fruit buds to form early—especially towards the base of the shoot.
- lightly heading or tipping (20%–25%) weak or moderate lateral shoots. This causes a moderate resumption of growth and weak lateral branching and development of fruit buds.
- leaving shoots alone in winter (or tying them down) to deinvigorate them and cause fruit bud development.

Treatment of the central leader: Each winter the tip of the central leader is headed back 2–3 feet above the previous season's whorl of branches. This causes it to branch and begin to form another whorl of branches, and to resume upward extension growth.

MCL trees can take up to 5–6 years to establish the entire tree framework. They involve a lot of pruning and limb positioning, with numerous heading cuts to develop and stiffen large permanent scaffold limbs. The extensive pruning and low tree density delay cropping.

Excessive vigor in the top of the tree is inevitable, especially with vigorous rootstocks such as M111. Failure to incrementally control this top vigor usually leads to excessive shading in the lower portions of the tree and poor fruit and fruit wood quality. This problem leads to the need for extensive major limb removal, which in turn throws the tree out of balance and begets



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Progression of the modified central leader system: first-, second-, and third-year pruning cuts.

excessive (in number), overly vigorous shoot growth that is almost impossible to manage at the expense of fruit production.

SLENDER SPINDLE SYSTEM

Features:

- Tree Height—6′–8′
- Spread at Base—5′–6′
- Space between Trees—4′–5′
- Tree Density—800-1,600 trees / acre
- Rootstocks—Mark, M9, M27
- Support—Individual stakes
- Labor Needs—Low; very little pruning; all operations can be done from the ground
- Cropping—2–4 years

The slender spindle tree works best with the planting of tall (4′-5′ foot) branch trees with 3–5 already established scaffold branches. Branched trees from a nursery are essential for early establishment and cropping.

The concept with a slender spindle tree is to quickly (1–2 years) establish a lower tier of 6–10 branches that are left unpruned. These branches are left long and will bear fruit in the second year after planting. Because of their length and the weight of the fruit, they may need to be tied up. If any of these branches are upright (45°-60° above horizontal) they should be tied down or weighted down to horizontal to encourage fruiting over extension growth. Once the lower tier of branches, which will bear 60%–80% of the fruit, have filled their allotted space, they are stopped by a shortening cut, which prunes into two-year-old wood and to a weak lateral branch or bud.

The central leader is supported by a pole and each winter is thinned out completely and replaced by tying up a lower, weaker lateral branch (see illustration). This replacement leader selection give the tree a slight S shape. This is done each dormant season until the tree achieves its desired height and then the leader is pruned into two-year-old wood to stop its growth.

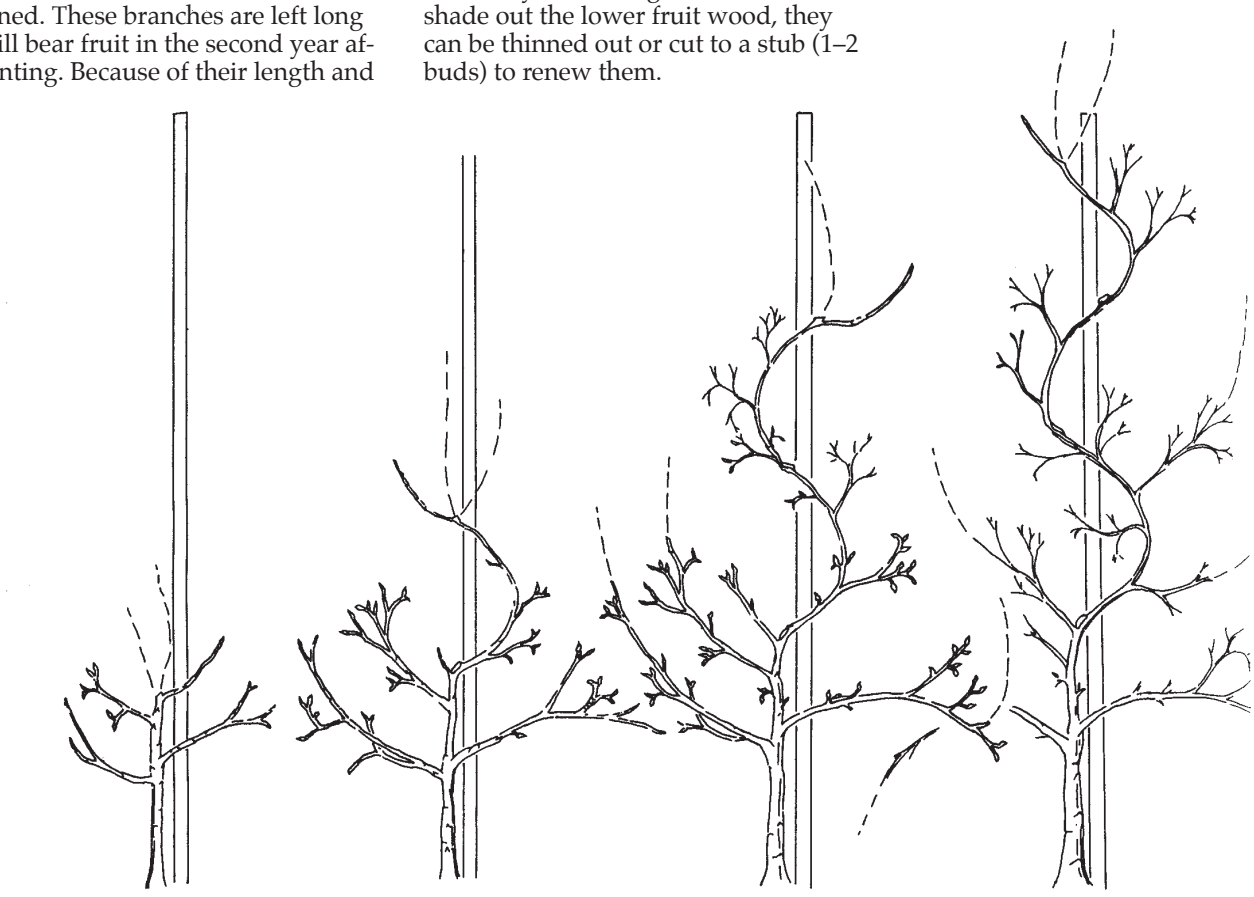
Above the lower tier of articulated branches, many weak lateral fruit-bearing branches form off of the leader. These branches should not extend out more than two to three feet. If, over time, they are too vigorous or start to shade out the lower fruit wood, they can be thinned out or cut to a stub (1–2 buds) to renew them.

VERTICAL AXIS OR FRENCH AXE

Features:

- Tree Height—10′–14′
- Spread at Base—5′–7′
- Space between Trees—5′–6′
- Tree Density—500–700 trees / acre
- Rootstocks—Mark, M9, M26, M7, M106
- Support—Individual pole or wire trellis
- Labor Needs—Low; very little pruning; all operations can be done from the ground
- Cropping—2–4 years

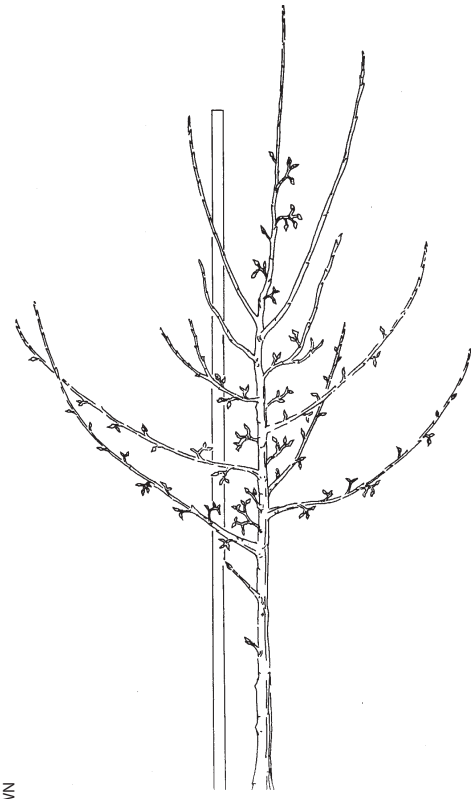
The vertical or French axe system features tall, narrow trees. The aim of this system is to let the tree achieve a natural balance between fruiting and vegetative growth, to reach its ultimate height very quickly (2–3 years), and to come into fruiting early. The vertical axe features almost no pruning in the early years. As with the slender spindle, the aim is to establish a permanent lower tier of branches that are trained



Progression of the slender spindle system: first-, second-, third-, and fourth-year pruning cuts.

to a horizontal position and left long (unpruned). Because the leader is not headed (even at planting), the tree form is very narrow and height is achieved quickly.

Above the lower tier of branches, weak to moderate lateral branches occur randomly. This system also features fruit-bearing on the main leader, which eventually slows tree height, as fruiting is usually more effective than pruning at dwarfing trees. Eventually the leader is pruned into older lateral wood. As the branches in the top part of the tree extend later-ally beyond their desired length of 2–3 feet, they are thinned out or renewed by cutting back to a stub (1–2 buds). The disadvantages of this system are the height of the tree, which requires ladder work, and overly vigorous branches high in the tree, which can shade the lower portions of the tree.



The vertical axis at year three.

HYBRID TREE CONE, "HYTEC" SYSTEM

Features:

- Tree Height—9′–10′
- Spread at Base—5′–7′
- Space between Trees—4′–6′
- Tree Density—600-1,000 trees/acre
- Rootstocks—Mark, M9, M26
- Support—Leader trained to individual pole, lower limbs tied up to poles to support weight
- Labor Needs—Low; very little pruning; all operations can be done from the ground
- Cropping—2–4 years

The hybrid cone tree is so named because of its cone shape and the fact that it is a blend, or hybrid, of two training systems—vertical axe and slender spindle. The establishment and maintenance of a lower whorl of unpruned branches that bear early and heavily is similar to the slender spindle system. However, the central leader is treated differently. In order to prevent the excessive tree height and dominance of top lateral branches of the vertical axe, the leader is manipulated both in the dormant season and again during active summer growth.

In the dormant season, bend the whole leader (not just the tip) to either a horizontal position, in the case of vigorous growth and strong scions, or to a 45° angle, with weaker growth and weaker scions. Bending the leader can be difficult, as it is often stiff. The leader should be tied to the support post. During the following summer, many weak branches 6″–12″ long and fruit buds will break into growth on the top side of the bent leader. These weak branches will not be vigorous enough to shade out the lower scaffold of branches. They will also be induced into early cropping by virtue of their position and inherent weakness.

During the following summer (May–June), re-bend the leader in the opposite direction. This technique reduces height and vigor in the top portion of the tree and causes flower bud initiation. This leader treatment continues until the tree reaches the desired height.

—Orin Martin

Nurseries

Dave Wilson's Nursery
19701 Lake Rd.
Hickman, CA 95323
www.davewilson.com

Northwoods Nursery/
One Green World
28696 South Cramer Road
Molalla, OR 97038
503.651-3005
www.onegreenworld.com

Raintree Nursery
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269.422-2411
www.southmeadowfruitgardens.com

Trees of Antiquity
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Paso Robles, CA 93446
805.467-9909
www.treesofantiquity.com

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The pruning systems described here and a large selection of dwarf and semi-dwarf apple varieties can be seen in the Alan Chadwick Garden at UC Santa Cruz. The Chadwick Garden is open to the public daily from 8 am to 6 pm. For information, call 831.459-3240, email casfs@ucsc.edu, or see casfs.ucsc.edu.

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