Training and Pruning Apple and Pear Trees

This publication describes the most important concepts in training and pruning of apple and pear trees. It is intended to help the pruner who already has some experience to improve pruning skills. Judgments about the kind and number of cuts to make in any particular tree should be based on its current condition relative to the desired objectives. This publication provides information about the advantages and disadvantages of various training and pruning systems and how to accomplish certain objectives.

You should recognize that there are several ways to train and prune trees successfully, but they require an understanding of the characteristics of tree growth. Pruning that ignores these characteristics may result in broken trees, low yield, excessively tall trees, and reduced fruit size and quality.

This publication first states a few facts about tree response (an understanding of which is basic to all pruning), defines terms used in pruning, and then describes the principal systems used for tree training. The last section tells how to prune bearing trees and contains advice on solving certain specific problems.

Basic Facts About Tree Response

These facts about tree response apply no matter what training and pruning system you follow.

1. Pruning a young, non-bearing tree always delays the onset of production and reduces the quantity of fruit produced in the early years.

2. Pruning stimulates growth near the cut; however, the net effect of pruning is to reduce the overall size of the tree and the relative size of the pruned limb.

3. Although pruning stimulates growth primarily near the pruning wound, other parts of the tree may grow more due to improved light distribution.

4. Apical dominance, in which the growing shoot tip produces hormones which move toward the earth's center, influences the number of shoot-forming vegetative buds, the lengths of the shoots formed, and their angles with the limb they emerge from.

5. The overall shape of the tree influences its productive efficiency through its effect on the distribution of sunlight throughout the tree.
6. Cuts made flush with the limb heal quickly, but stubs left don't heal.

7. Limb spreading affects the tree in several ways.

    a. The unspread upright limb produces the longest shoots near its apex.
    b. Moderate limb spreading, 30 to 60 degrees from vertical, reduces the vigor of shoots near the apex while increasing the number of shoots formed and the length of those farther away from the apex.
    c. Wide spreading exaggerates this difference in the position of long shoots but may reduce the total number of shoots formed. The degree of response varies considerably with variety. Spreading limbs excessively or when the tree is too young will require heavy pruning to remove upright shoots.

8. Two basic kinds of cuts in training or pruning are heading back and thinning out. Heading means cutting off part of a shoot or branch. Thinning means taking out the entire branch or shoot.
9. Shoots that form a narrow angle with the trunk of a young tree will become main limbs with narrow angles. Narrow crotches include bark, are weak and split easily, and are more susceptible to cold injury. Winter ice forming in the narrow crotches expands and may split the trunk. Avoid narrow crotches by selecting shoots that form wide angles with the trunk or other branches, or by artificially spreading the young shoots as they form.

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10. Shoot versus spur. The term "shoot" refers to the past-season's growth in winter or a current season's growth in summer. A "spur" is a very short shoot that usually terminates in a flower bud. A "spur system" is a cluster of "spurs" which originated from a single shoot.

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11. Fall or early winter pruning can increase the susceptibility of trees to damage in a sudden freeze within two weeks after they are pruned.

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Both apple and pear trees benefit from skillful annual pruning but they differ in their response to pruning. Different varieties of pear or apple or the same variety grown on a different rootstock respond differently to pruning. To become a masterful pruner you must prune and carefully observe the results on the same trees for several years.

Clases of Growth and Fruiting Habit

Growth habit refers to the overall growth pattern of the tree and includes carriage (upright to spreading), crotch angles (narrow to wide), and branching (many to sparse).

Fruiting habit refers to the overall pattern of pruning and includes fruiting on the ends of long or short shoots, age of spurs which produce most of the crop, and production close to the trunk or rapidly evolving toward the extremities of scaffold limbs.

Most apple varieties can be classified as one of the following four types according to growth and fruiting habit.

Type I, spur types, characterized by Starkrimson Delicious. Type I trees tend to be upright with narrow crotches and sparse branching. Fruiting occurs on numerous short spurs which are

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long lived. The zone of fruiting tends to remain close to the trunk.

Type II, characterized by most "standard" non-spur strains of Delicious. This is a variation of type I in which branching is more frequent and there is a greater tendency for the fruiting zone to move away from the trunk.

Type III, characterized by ("standard") Golden Delicious. Type III varieties tend to be spreading with wide crotches and frequent branching. They bear on spurs and shoots which are generally 1 to 3 years of age. The fruiting zone tends to move rapidly away from the trunk to the outside of the tree.

Type IV, the "tip bearers," characterized by Rome Beauty, Granny Smith, and Tydemans Early Worcester. Type IV varieties tend to have upright main scaffold limbs with narrow crotches and frequent branching. They bear much of the crop on the ends of the previous year's shoots. There is a strong tendency for the lower half of the shoots to be without leaves or fruit, that is, "bare" or "blind." There is a strong tendency for the fruiting wood to move toward the extremities of the branches with tree spreading as a result.

Tools for Training and Pruning

Proper tree training involves cutting into small wood, with hand shears. About the third or fourth season long handled pruning shears, often called "loppers," are useful in reaching the higher limbs. Do not use power pruners, especially mowers, to train apple and pear trees. The cuts made by power tools will be too numerous and often too large. Frequent sharpening of pruning tools makes the work faster and easier.

You'll need a ladder or some kind of man-positioning machine for the work. Since ladder falls are the most frequent and costly source of injury in orchards, make sure you have a good ladder, the right size for the tree, and that you know how to set it properly. Before operating a man-positioning machine, be sure that you have been thoroughly instructed in its use and daily maintenance.
Power saws sometimes used in pruning may be electrical, pneumatic, or hydraulic. Small gasoline chain saws may also be used. Power shears are either hydraulic or pneumatic. There is a tendency, when using power tools, to make too many large cuts. Do not let the tools you use influence your judgment in pruning. Do not leave stubs, as they often produce unwanted shoots and provide an entry point for wood rots.

Training

In contrast to pruning, the purpose of training is to direct growth into a well-designed tree structure.

Except for moderate summer heading, pruning for training always delays blossom bud formation and reduces fruit production in the early years. Most training should be done in the first two or three seasons when you use only a few small cuts.

Height of heading at planting time.

Delayed heading to remove the highest shoots produces framework shoots with wider angles than a single heading cut at planting time. Delayed heading is not necessary in central-leader trees because the leader stimulates wider angles below.

Training to a central leader

Use central leader training in apple orchards with tree spacings about 8 to 12 feet or closer in the rows and 14 to 18 feet between rows where tree height is confined to not more than 10 to 12 feet. It is difficult to position a ladder to gain access to the tops of central-leader trained trees that are more than 12 feet tall. Granny Smith, a type IV variety, is best grown on a dwarfing or semi-dwarfing rootstock with a central-leader.

Although central-leader training has been used in pear orchards, severe tree losses have been experienced when fire blight struck the leader and ran straight down. Use three or four leaders in pears to protect from this danger. The central leader system is not convenient with Bartlett or Bosc pears because young trees of these varieties lack the required structural strength. Central leader training assures development of a conic tree shape that uses sunlight efficiently. The limited tree height and spread with this system makes it ideal for semi-intensive plantings.

Because of a tendency for strong apical dominance, it is easy to train pear and apple trees to a central leader, provided certain rules are followed.

First, establish the dominant position of the central leader by removing or spreading competing shoots and heading the central leader. Maintain the dominance of the central leader by lightly pruning in early summer. This results in greater net growth of young trees than more severe dormant season pruning.

There is much variation among varieties in the tendency to branch and to form wide crotch
angles naturally. Varieties with narrow angles and sparse branching require removal of shoots which compete with the leader two or more times during the first growing season, while a single summer training will suffice for others.

The central leader makes spreading of young scaffold branches much easier since there is always the one central shoot to support the spreader. Spread scaffold branches about 60 degrees from vertical just before pruning so that you can easily see what pruning is needed. Thin the ends of scaffold branches to a single shoot. Head only those shoots where branching or stiffening is desired to an outside bud, removing about one-third of the shoot. Heading reduces flower bud formation.

If the upper portions of the central leader are allowed to fruit in the early years, the tree will easily bend out of shape and will not make a satisfactory amount of growth. Do not allow fruiting on one year old wood.

Solve the fruiting problem by removing the fruit or by supplying artificial support for the central leader. Choose whichever method is economically better for you.

It is difficult to develop a well-balanced central leadered tree on a windy site. Using an artificial support to hold the tree into the wind may enable development of the tree without excessive pruning.

Tie the trunk and as the tree grows larger tie some limbs into the wind. Supplement this effort by pruning to buds that are pointing into the wind.

Training to a modified leader

The idea of this system is to develop a strong basic tree structure by starting with central-leader training but finishing with a multiple-leadered tree. A temporary central leader helps obtain wide-angled crotches both by the hormonal influence and by affording a place to insert spreaders. It facilitates the selection of main scaffold limbs.
spaced about a foot apart on the trunk, which also contributes to tree strength.

The modified leader system is used primarily for apple trees whose ultimate height will be 14 feet or taller with an equal or greater spread. This system has not been popularized in pear-growing districts.

Use either central or multiple-leader training for apple varieties with any of the four growth habits described earlier.

Select three to six primary scaffold limbs around the trunk and head as required to stimulate branching. They should branch about two feet out from the trunk. Space these 8 to 12 inches apart vertically. Head the leaders in the dormant season to cause branching. Do not head secondary branches.

Multiple-leadered spur-type apple trees may have seven to nine scaffold limbs, which permit the renewal of fruiting wood by removing entire scaffold limbs. Use three or four main scaffold limbs for pear trees: select limbs with strong crotches and spread these against one another or tie the limbs out with strings fastened to clips in the ground. Thin out the ends of the scaffold limbs to a single shoot and head it lightly. The weight of fruit will further spread the tree.

The main purpose of limb spreading in a multiple-leadered tree is to obtain strong crotch angles. Excessive spreading will open the center of the tree too much, stimulate unwanted inside growth, and make it difficult to maintain an overall conical tree shape. Good light penetration depends on conical shape more than openness of center. Avoid equalized limbs in secondary scaffolds as they will interfere with the dominance of the leader. The leader should terminate in a single upright shoot.

If a young tree is neglected in the first few seasons it will require severe pruning to correct a weak framework. If there are so many scaffold limbs in one place that none can develop vigorous secondary limbs close to the trunk, remove some

Tree trained to a modified leader (a) spreaders help to obtain a strong framework.

Training to multiple leaders

Multiple-leader training is best for large apple trees and pear trees where central leader training is not desired because of fire blight or tree size.
by sawing them off flush with the trunk. Do not leave a stub. Remove only one or two big limbs per year.

How growth type affects training

While it is possible to train every variety without deviating from a single system, you can obtain better results with greater ease by allowing for growth types. In central leader training, leave more secondary scaffolds on the sparsely-branched type I (spur-types) and type II than on the more freely-branching types III and IV.

The number of primary scaffold limbs in multiple leader training should follow a similar pattern with seven to nine for type I, four to six for type II, and fewer for types III and IV. This allows the spur types (I) to spread more, but limits the spreading of types III (Golden Delicious) and IV (Rome, etc.).

The “tip bearers,” which tend to have long portions of shoots without leaves or spurs (type IV), include Rome Beauty, Granny Smith, Tydemans, and others. These need frequent heading to stimulate branching and minimize the blind wood. Unless the tree is on a flower-promoting rootstock such as M 106 or M 26, heading will greatly delay the onset of production.

The four principal pear varieties grown in the Northwest can be separated into two groups according to the strength of their wood (tendency to droop or weep under the weight of leaves and fruit), the age at which the tree generally begins to bear, and by their tendency to fruit on the ends of shoots rather than setting on spurs exclusively.

Anjou and Comice have strong wood and seldom bear fruit on the ends of shoots. Bartlett and Bosc have weak, flexible wood. Frequently Bartlett sets fruit terminally on shoots. Anjou and Comice usually require several more years before they begin to bear than Bartlett or Bosc. Spreading limbs on Comice and Anjou hastens the onset of production. When artificially spread limbs of Bartlett and Bosc bear fruit they are weighted down below horizontal, the terminal stops growing and forms unwanted suckers. Spread Comice and Anjou. Head long shoots of Bartlett and Bosc, but be careful not to do too much spreading. Extensive spreading followed by heading of shoots formed in response to spreading has greatly hastened the onset of commercial production of Anjou pears.

### Intensity of spreading and heading required relative to growth habit.

<table>
<thead>
<tr>
<th>Growth of main scaffolds</th>
<th>Chara-</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Variety</td>
<td></td>
<td>Spreading</td>
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<tr>
<td>I</td>
<td>7-9</td>
<td>Starkrimson</td>
</tr>
<tr>
<td>II</td>
<td>4-5</td>
<td>Delicious</td>
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<tr>
<td>III</td>
<td>4</td>
<td>Golden Delicious</td>
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<tr>
<td>IV</td>
<td>3-4</td>
<td>Rome Beauty</td>
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**Orchard Design**

Tree 16 feet tall, 30 feet wide

If trees are much wider than they are tall, the limbs will not support the crop without props, traps, or ties. The limbs will be nearly horizontal and will be prone to suckering. Heavy growth on tops of low, wide trees limits light penetration to lower limbs. Fruit on shaded limbs is small and poorly colored. The limbs become weak and may die.

Tree 16 feet tall, 15 feet wide

To avoid these problems, space trees about as far apart as their final height will be, keep the primary scaffolds fairly upright and the secondary scaffolds short with more spreading. Trees in hedgerows may be taller than they are wide.
Maintain ladder bays between the scaffold systems for more convenience in picking and pruning. With large trees ladder bays also facilitate spraying.

Pruning Young Trees

Finish training for basic tree shape by the fifth season. Prune young trees to control tree height, to improve fruit quality by reducing limb rub, and to prevent excessive spreading of limbs under the weight of fruit.

In young trees, the equilibrium between fruiting and growth is easily tipped in the direction of growth by too much pruning. Too much vigor gives excessive growth and small crops of large fruit are subject to bitter pit or cork. Obtain greater production through light pruning combined with strapping, wiring, or propping to keep the fruit from breaking limbs rather than by heavier pruning to further increase limb strength. (The extensive heading used in the spreading-and-head system for young Anjou pear trees is an exception.)

Also remember that pear trees stimulated to rapid growth by pruning are more susceptible to fire blight.

Make relatively few cuts on the tree. Removing one-year shoots if the tree is growing more than is desired or if there are few flower buds due to a heavy crop the previous season or to freeze damage. Any corrective pruning required on young trees, such as removal of excess limbs, balancing leaning trees, or reduction of height, should be done gradually over several seasons to minimize the stimulatory effect.

Fruiting habit effects on apples

Type I, the spur type. Since spurs are long-lived, it is not necessary to prune this type as much to renew fruiting wood as it is with trees with other growth habits. If the tree is growing vigorously, accomplish renewal with a few large cuts to remove whole limbs back to six or seven year old wood. Usually a vigorous shoot forms near the cut, which if left alone, will serve as a replacement limb. Accomplish renewal with a few cuts low on the tree. On trees with "dead bud" disorder or spur-type trees which lack vigor, extensive heading is needed to maintain tree vigor and to renew spurs.

Type II, "non-spur" Delicious. More cuts into younger wood are required to force spurs and side branches in Type II trees. Make well-distributed lopper cuts to remove limbs which have 5 or 6 year old spur systems. Always cut at a branch point in order to avoid leaving a stub.

Type III, Golden Delicious. More frequent cutting further from the trunk is required to keep a majority of spurs in the 1 to 3 year old class. Selectively remove the downward hanging older fruiting wood.

Type IV. A relatively large number of small cuts near the trunk is necessary to keep a high percentage of fruit spurs in the 1 to 3 year old class. Cut to an upright shoot where the branch arches.

Fruiting habit effects on pears

Bartlett and Bosc. Thin out the previous season's shoots and leave the remaining shoots unheaded except those which are so long that they would be distorted by wind or fruiting. Heading all shoots reduces both yield and fruit size.

Anjou and Comice. Fruit set usually limits production more than the quantity of bloom. Do not head shoots formed the previous season. Either leave the entire shoot uncut or remove it completely. Head at a flower bud in 2 or 3 year old wood.

First dormant season
Second dormant season

Strong scaffolds and a cone-shaped tree are developed without bench cutting.

Third dormant season

Occasional bench cutting is useful in direct-minor secondary and tertiary scaffold limbs. Apical dominance helps control suckering in tree tops.

Enlarged drawing showing fruit spurs

“Bench cutting” leads to weak limbs and an umbrella-shaped tree.

Once the young tree has reached the desired maximum height, establish a renewal point on the leader by thinning to an upright shoot each year. Head the shoot to keep it stiff and upright and to prevent distortion by wind.

Terminal cut to outside wood suckers profusely.

For most current information: http://extension.oregonstate.edu/catalog
Terminal cut to upright wood forms fruit spurs and few suckers.

Central leader trees

The central leader pruning system is a continuation of the training procedure, except that spreading is no longer needed. Horizontal branches may need to be tied up, however. Remove all upright shoots on upper sides of scaffold limbs. Thin the ends of scaffolds and the central leader to a single shoot. Remove or thin out weak spur systems.

Amount of pruning on trees of this age. Remove vertical suckers on the upper side of scaffold limbs every year. Unless the top portions of the tree are suppressed by pruning, they will overgrow, shade out, and weaken the lower limbs. Remove extra limbs which have been left in the tree to increase early-year cropping before such limbs begin to crowd.

Multiple-leader trees

First prune out limbs extending into the ladder bays, then start the detailed pruning from a position in the top of the tree high enough to look down on the whole scaffold system. If the tree is too tall to do this, either get a taller ladder or cut out the tree top. Always cut to a lower limb to the point where it can be reached easily for pruning. Remove or cut back horizontal or downward hanging branches in the upper-outer portions of the tree. Thin the shoots around the ends of all main and secondary scaffold limbs to a single upright shoot.

Do not leave forks on branch ends. This will encourage spur and shoot development further back on the branch by increasing light penetration; discourage excessive spreading by removing the weight from ends of branches; and prevent development of excess unwanted shoots through maintenance of apical dominance.

This shows the fifth dormant pruning of a well-trained central leadered tree. Do a minimum
Move downward through the tree, pruning more lightly as you go. Give preference to removing the thinner spurs underneath limbs. Renew old spur systems by cutting them part way or by knocking them off to favor newly formed spurs. Keep replacement leaders coming on the sides of scaffold limbs and cut back to them as the outer portions become too horizontal or drooping. Thin out shoots to desired spacing and lightly head the longer ones.

**Pruning Mature Trees**

Mature trees require more pruning than young trees. In addition to maintenance of height and spread, it is necessary to maintain ladder bays. Renew fruiting wood in the same manner as described for young trees.

Trees that have not been pruned for several years are overgrown and bushy. Restore the balance of vigor and fruitfulness in trees by making many thinning cuts throughout the tree with emphasis on the upper, outer portions. Cut into wood that is several years old at an upward growing branch or shoot. Do this for several years. Remove no more than one or two large limbs per year. Too much pruning at one time may cause the tree to stop producing.

Excessive suckering may be due to loss of apical dominance on nearly horizontal limbs, excessive pruning and/or excessive use of fertilizer. Suckers or "water sprouts" may be removed in summer.

In a well-pruned tree, the shoot growth is evenly distributed through the bearing limbs from bottom to top. Most spur systems have some new shoot growth. Maintain even growth by making many cuts into thin wood throughout the tree. There are few suckers to remove because cuts are evenly distributed and apical dominance is maintained.

The "umbrella-shaped tree" is the result of failure to cut into older wood and always pruning to outside wood. New growth consists primarily of suckers in the tree top. Lower limbs are weak and shaded. There is little new growth in the weak, devitalized spur systems. Much time and effort is expended annually in the removal of suckers and in placement of props.
A common mistake made with central leader trees in close planting is to allow the top to become too dominant. This reduces growth of lower scaffolds and shading occurs.

Constantly subdue the top of central leader trees by pruning.

Pruning limb ends to more upright shoots helps maintain a good equilibrium of fruiting/shoot growth. If the tree were pruned to horizontal or hanging branches, apical dominance would be lost, the equilibrium would be shifted toward shoot growth, and the tree would produce many suckers.
The pruning of "umbrella-shaped trees" can be reversed gradually if they are not too old. Yield will decline temporarily during the conversion.
Controlling suckering in mature trees

First year. A typical "sucker crown" found on the upper side of the highest branches of a mature tree.

a. Leave a vigorous vertical sucker in the center; head it.
b. Leave a few weak suckers with wide angles; do not head them.

Second year

a. The vertical, headed sucker will grow vigorously, suppressing growth of shoots below due to apical dominance.
b. Unheaded weaker shoots will set flower buds.

Third year

a. The central, vertical sucker is renewed in its dominant position each year by cutting to an upright shoot.
b. The weak, unheaded suckers bend under the weight of fruit and form spur systems.
Wrong practice

The weak, pendulant spur systems of "umbrella trees" have little new shoot growth.

Right practice

Removal of the lowest hanging spurs and thinning the others stimulates shoot growth near the spurs.

Mechanical topping and hedging is sometimes used in an attempt to reduce labor costs. If misused, it can reduce yield and fruit quality so that a serious net loss occurs even though some savings were made in pruning costs. Masses of new shoots form along the plane of cutting and lower, inner wood is weakened or dies due to shading. Mechanical pruning best confines the tree to its allotted height and spread before hand pruning commences. Do not reduce the height or spread of trees with mechanical pruning more than about 2 feet in a single season. Always thin out the excess shoots formed by the previous season's mechanical pruning. Prune by hand throughout the tree to stimulate growth away from the area by topping or hedging.