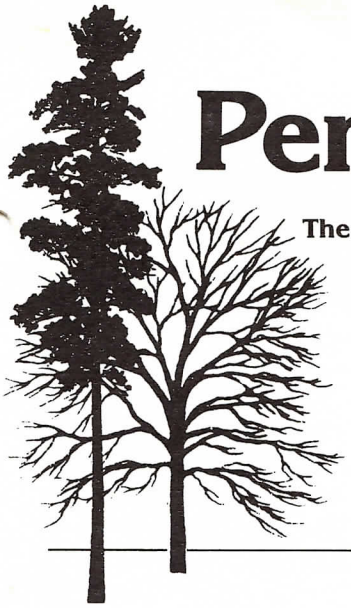

Pennsylvania Woodlands

The Pennsylvania State University, College of Agriculture, Cooperative Extension Service

The how and why of TSI: forest improvement

NUMBER 3

TSI, or *timber stand improvement,* is a necessity in most previously unmanaged forest stands in the Northeast. Decades of poor forest practices, including grazing, overcutting, and high grading, have resulted in forest stands stocked with poor quality trees. Where owners or loggers have removed only the most valuable trees for market (high grading), less valuable species and individual trees have reproduced and occupied the space. Overcutting may have resulted in open areas where branchy "wolf" trees, less valuable tree species, or shrubs have taken over space needed by less aggressive but more valuable timber species.

To prepare these stands for future harvests of high -quality timber, and to increase their visual and wildlife qualities, improvement cuttings are essential. Timber stand improvement is basically weeding a forest and preparing it for productive use. If the quality of a stand has deteriorated beyond a certain point, a regeneration cut or stand conversion may be in order. If that point has not been reached, one or more well-designed improvement cuttings should put the stand back on a productive course.

To understand the *purpose* of TSI, it is necessary to understand how a forest stand develops. Most existing stands in Pennsylvania originated following a major disturbance, such as land clearing for homesteads or farms, fire, or past harvests.

Following such disturbances, thousands or tens of thousands of seeds may germinate and grow into small trees. As they grow larger and crowd each other, competition increases for light, moisture, and nutrients. The most vigorous trees grow taller and expand their crowns. They become the *dominant* trees in the stand. As less vigorous trees are crowded by these dominants, their crowns become misshapen and restricted. If they can compete successfully enough to maintain a place in the canopy, they are called *co-dominants.* These co-dominant trees receive light from above, but crown growth is restricted on the sides. Trees of *intermediate* crown classes are shorter than dominant or co-dominant trees and receive little light. *Supressed* or over-topped trees are totally below the main canopy. They receive no direct sunlight and eventually die. A forest is a very dynamic environment. Changes are constantly occurring; a tree which dominates a forest stand one year may the next year fall to disease, insects, or natural disaster. Of the tens of thousands of seedlings beginning life in a forest, less than 100 per acre may survive and thrive to become mature trees suitable for harvest.

The crown ratio (or percentage of the tree with live branches or leaves) indicates the relative vigor of a tree. With a crown ratio of ⅓ to ⅖, a dominant or co-dominant tree is able to take advantage of openings in the canopy to expand its crown and to increase its growth rate. Trees with lower crown ratios, or trees of lower classes, do not have the resources to thrive. Those with higher crown ratios are too branchy to produce quality timber.

Timber stand improvement (TSI) gives you the opportunity to select and encourage the dominant and co-dominant trees which will become your final crop trees.

TSI consists of a series of operations, some of which may be combined to reduce labor and material costs. The following terms describe these operations.

- Crop tree selection: choosing which trees to encourage.
- Liberation cut: removing over-topping trees to reduce competition to sapling-sized crop trees in understory.
- Weeding: removing undesirable species or individuals competing with crop trees in sapling-sized stands (1 to 4 inches dbh).
- Improvement cut: weeding done in pole-sized (4 to 10 inches dbh) and larger stands.
- Thinning: removing nearby trees to further encourage crop trees.
- Pruning: removing lower branches to improve quality.

The objective of TSI is to provide optimum growth of selected trees. This is done to encourage early financial returns - and to promote healthy and vigorous forest stands.

TSI work may require inputs of time and money with no immediate return. However, the increased return from high - quality timber products and a healthy forest environment should more than repay earlier investments. Increased use of wood for home heating has expanded markets for the material generated by timber stand improvement. Federal or industrial cost-share or assistance programs may be available in your area to further reduce your immediate costs.

Your management objectives as well as physical and financial resources determine how much TSI work you undertake. A thorough job of improvement in part of your woodland probably will net more gain than a half-done job throughout your entire property.

Trees need room to grow. If they are too close to one another, they must compete for water, nutrients, and sunlight. By removing competing trees, you are releasing the trees you choose to favor (crop trees) from competition and encouraging their growth. If you remove only a few of the competing trees, the remaining undesirable trees will use nutrients, water, and sunlight which could be increasing the growth of selected crop trees.

SELECTING CROP TREES

Your objectives will dictate the tree species you wish to favor. Ideally, each timber crop tree should be straight, tall, vigorous, and free from obvious defects. Figure 1 illustrates characteristics of the ideal crop tree. Pole-sized timber (4 to 12 inches in diameter at breast height, 4.5 feet above ground level) will respond best to release. To increase its vigor and growth, the crown of a crop tree should have a space of 3 to 4 feet on at least two sides.

Selecting crop trees will take time, but ultimately will result in an improved forest environment, and increased economic potential. A simplified method of selecting crop trees is to pace 15 to 20 feet from the edge of your forest stand and mark (with paint or flagging) the tree which best meets the criteria for crop trees.

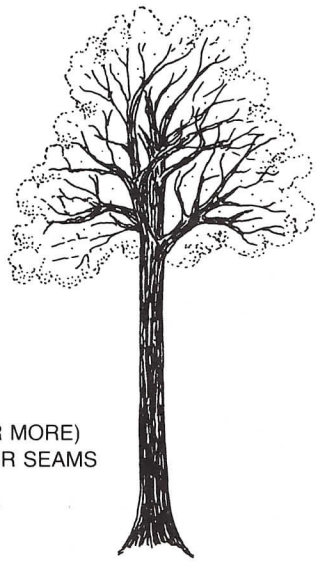

Figure 1. Ideal crop tree

Permanent marking is not necessary, as over time, certain crop trees may fall from favor. Twenty feet farther on, select another crop tree. As nature does not follow strict patterns, you may have to search an area 5 to 7 feet around the ideal spot to locate a suitable crop tree. If no tree is up to standard, select the best tree. Save it to avoid large openings in the crown which may encourage invasion of undesirable shrubs, forbs, or grasses. If there are no trees at all, move 20 feet down the line. By a series of such selections you should end up with 100 to 150 crop trees per acre, spaced 15 to 25 feet apart.

If your stand has not been treated previously, many of the non-crop trees probably will be of low quality. Do not mark every reasonably good tree as a crop tree, as this defeats the purpose of your work. If you don't remove them now, nature will select many trees in a crowded stand for destruction before they reach maturity. This is your opportunity to help nature and yourself by removing those of lesser values.

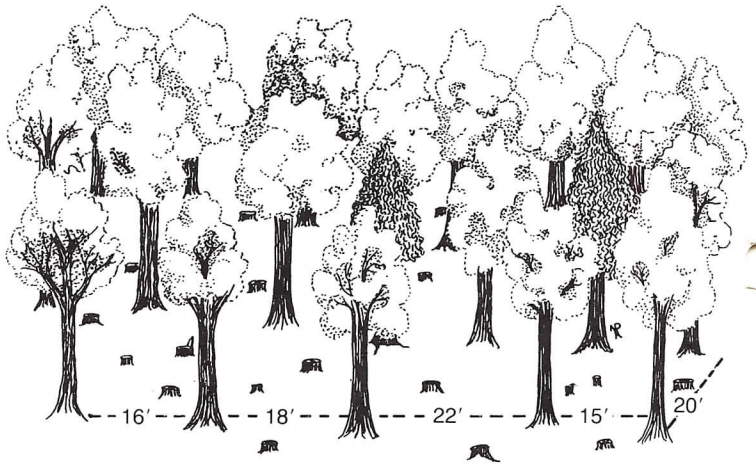

Figure 2. Well-spaced crop trees

If you discover a good crop tree which does not fit into the 15 to 25 foot spacing pattern, mark it. So long as you allow it enough space to grow, it should be a good investment.

The trees you select as final crop trees, and the trees you choose to remove, will depend on your management objectives. Species selection greatly influences the ultimate value of your woodland. A professional forester can help you assess the potential of various species present in your woodland. See *Pennsylvania Woodlands #2* for additional information on multiple-use management.

The crop trees you retain will benefit from reduced competition whether the adjacent trees are cut and removed or are killed in place. If fuelwood or pulpwood markets are available, or if you will use the wood yourself, you may profit by cutting wood yourself or selling the cutting rights. If you haven't the resources to cut and remove trees, they may be killed. Killing trees in place by girdling or frilling may result in increased

numbers of den trees and slow recycling of nutrients in the forest environment. Gradual deterioration of trees will reduce damage which could occur to crop trees if culled trees are felled and removed. However, careful logging and removal will speed the release of crop trees and permit use of the wood. The economics of cutting versus killing must be decided according to individual objectives and the financial and physical resources available.

The most common methods of killing trees are girdling (cutting the bark around the entire trunk) or frilling and applying approved chemical herbicides. Girdling may be done with an axe or chainsaw. The cut must be complete and deep enough to sever all living tissue connecting the roots to the crown. Frilling is accomplished by spaced or connected - axe cuts made around the tree, followed by application of chemicals. Frilling generally results in more rapid and certain death. Slow killing (by girdling or frilling) will protect understory trees from immediate and severe exposure to sunscald and frost, and may reduce the incidence of epicormic branching on crop trees.

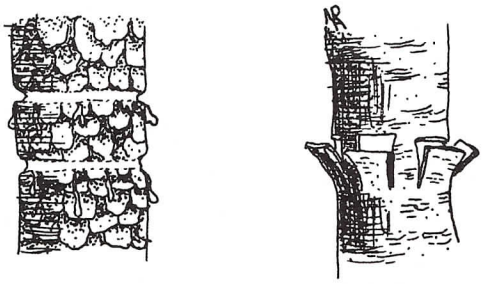

Figure 3.

Epicormic branches develop from dormant buds beneath bark on tree trunks. If the tree trunk is exposed to sufficient light, after surrounding trees are removed, buds will grow into branches. Knots resulting from formation of epicormic branching reduce the quality of wood. Detailed information on girdling and frilling is contained in the Extension publication, *Forest Resources and Herbicides,* Special Circular #278, The Pennsylvania State University.

WEEDING, THINNING, LIBERATION, AND IMPROVEMENT CUTS

These practices are designed to reduce competition to crop trees. Weeding and liberation cuts are performed in relatively young stands where trees are 1 to 4 inches in diameter. Weeding removes undesirable or less valuable species and poorly formed individual trees. Liberation cuts remove trees which are overtopping crop trees, reducing available sunlight, and competing in the root zone for water and nutrients.

Thinning and improvement cuts are performed in older stands, where trees exceed 5 inches in diameter. If prior timber stand improvement has not been performed, many trees will be suitable for removal.

Trees to remove:

- Those competing with selected crop trees
- Diseased trees
- Overmature trees
- Crooked or sweeping trees
- Forked trees
- Wolf trees
- Trees with broken or seamed bark
- Trees with large or poorly healed branch stubs
- Weed species
- Species favored by gypsy moths, if there are only a few such trees

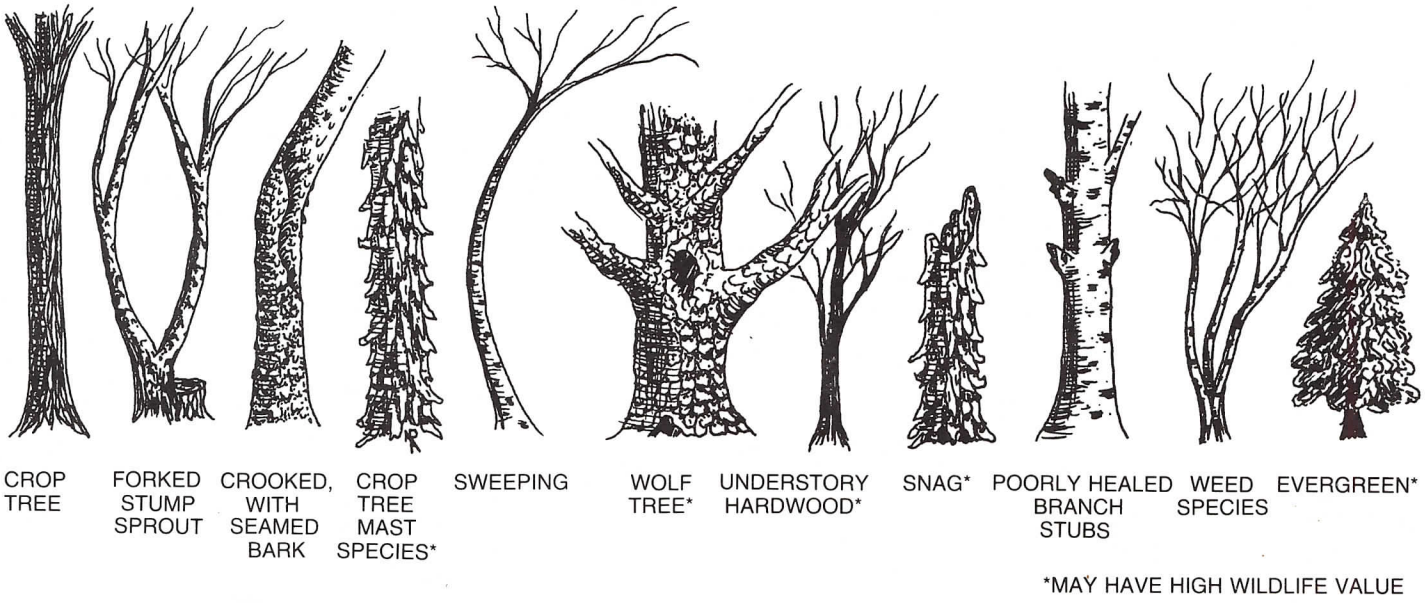

Figure 4. Trees to consider in TSI

A seriously neglected stand may have few individuals of good quality; removing all defective and overtopping trees may expose the remaining individuals to risk of sunscald, epicormic branching, or windthrow (being blown down in stormy winds). If few quality trees exist, two or more light cuttings separated by intervals of 5 to 10 years may be preferable to one heavy cut.

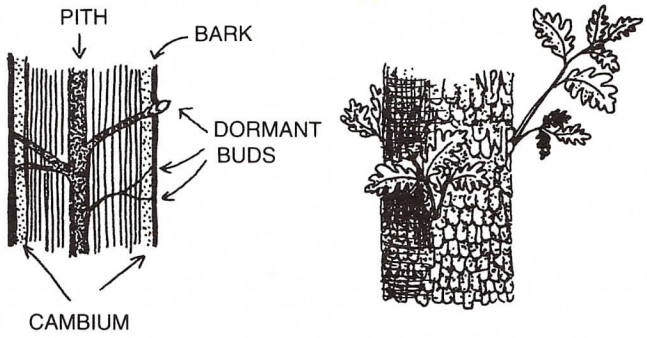

Figure 7. Epicormic branching

If timber production is your prime objective, you may wish to consider a regeneration cut to improve crop tree density. Low density means you have room to waste, rather than room to grow. If trees cannot fully occupy the site by closing openings in the canopy, you are wasting resources. You also are opening your forest stand to invasion by plants which may be detrimental to existing trees or which may prevent future reproduction.

When timber production is not your only management objective, you may wish to leave a few individual trees with particular wildlife or aesthetic values. One or two den trees and snags per acre, and some evergreens and mast (nut producing) trees, will provide shelter and food for wildlife. To you, the aesthetic value of a flowing dogwood or a wolf tree may outweight its negative effect on surrounding trees.

HOW MUCH TO REMOVE

A sustained yield (continuing supply) of defective trees is not your objective. For this reason, artificial limits should not be set on the volume of wood removed in an improvement cut. You should remove as much of the defective material as you can physically and financially afford. Concentrate on removing those trees immediately adjacent to selected crop trees without creating unduly large openings in the canopy. Once your initial cut has been made, crop trees and other trees which remain should increase their growth rates and vigor. When the trees have grown to occupy the site fully (10 to 15 years on good sites), you should consider a second improvement cut or a thinning. Closure of the openings you have made in the canopy indicates that another improvement cut or thinning may be appropriate.

The second cut will remove additional cull trees and trees which are now crowding final crop trees. Understory trees need not be removed as they act as trainers, encouraging loss of low branches on crop trees. This second cut may well provide some saleable sawtimber or pulpwood. A professional forester can appraise your stand and assist you in marketing timber. Using quality timber for firewood is a waste of valuable resources as well as money.

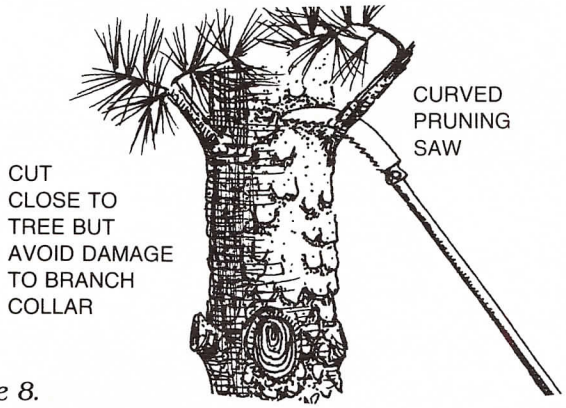

Figure 8.

If your cutting plan has been well designed and closely followed, your timber stand should be well on its way to providing what you want from it. You may wish to prune selected crop trees for reasons of timber value improvement and aesthetics. Careful pruning, begun early in a tree's life, may increase its value substantially. Veneer-quality logs and clear-lumber logs generally command premium returns; a carefully pruned stand provides an attractive view. Pruning of hardwoods is not a common practice, but can be done for aesthetic reasons.

Pruning should begin when a tree is pole size, or 4 to 10 inches dbh (diameter at breast height). White pine is most often pruned. But red and white oaks, yellow birch, black cherry, spruces, and other species also may increase in value after pruning. Saw off all branches less than 2 inches in diameter, and to a height of 17 feet. If there are no crop trees capable of producing clear 16-foot logs, prune trees to 9, 11, 13, or 15 feet. Do not remove more than one-third of the live branches on a tree. A cut on the underside of larger branches, before sawing from the top, helps prevent tearing of live tree tissues. A straight saw for undercuts and a curved pruning saw will make the job easier.

Successful timber stand improvement involves planning and work. The ultimate results are more valuable timber and fuelwood, plus a vigorous, productive forest stand. An added benefit is the satisfaction of knowing you have fulfilled your role as a manager and steward of woodland resources.

Prepared by Nancy Pywell,
Instructor, Forest Resources Extension

Issued in furtherance of Cooperative Extension work, Acts of Congress, May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture and the Pennsylvania Legislature. S. H. Smith, Director of the Cooperative Extension Service, The Pennsylvania State University.

File No. IV11d 5M483 U.Ed. 83-575