CHAPTER 4

SILVICULTURE

4–1. General

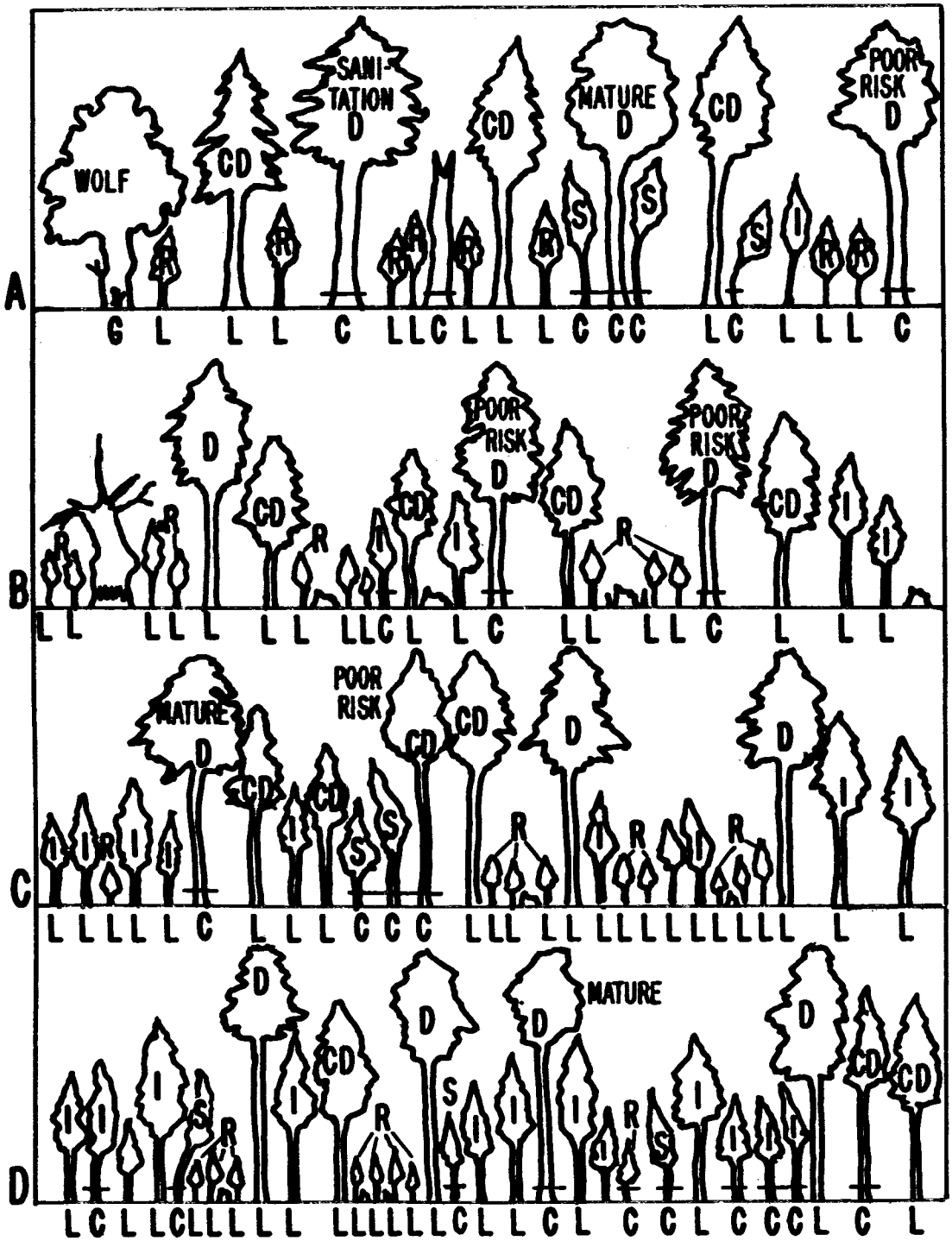
4–1.1. Silviculture is, generally, the science and art of growing and tending forest crops, based on a knowledge of silvics. More particularly it is the theory and practice of controlling the establishment, composition, stocking density, and growth of forests.

4–1.2. In an unmanaged forest, there is a continuous loss of valuable wood in trees that die of old age, trees killed by fire and disease, and trees unable to survive the competition for food and moisture. By applying silviculture, the volume otherwise wasted is reduced by utilization, and more trees of greater volume and better quality reach maturity.

Note: Some insect and disease problems are mentioned in this chapter. For more complete information, see chapter 9 of No. 3, appendix D.

4–2. Forest Regions.

4–2.1. Northern Region (Fig. 4–1): The principal forest cover-type groups of the Northern Region are—



A. FIRST CUT, UNDERSTOCKED, UNMANAGED, DECADENT STAND
B. SECOND CUT, END OF FIRST CUTTING CYCLE, LIGHT
C. THIRD CUTTING, END OF SECOND CUTTING CYCLE, VERY LIGHT
D. FOURTH CUT, END OF THIRD CUTTING CYCLE, MOSTLY PULPWOOD

LEGEND

C-CUT	CD-CODOM.
G-GIRDLE	I-INTER.
L-LEAVE	S-SUPPR.
D-DOM.	R-REPRO.

Figure 4-1. Forest Regions for Continental United States.

Type groups and forest cover types	Principal associated species
White-red-jack pine	White, red, jack pine; hemlock; quaking and bigtooth aspen; paper, yellow, and gray birch; red maple; and northern red, white, and chestnut oaks.
Spruce fir	Red, black, and white spruce; balsam fir; hemlock; northern white-cedar; and red maple.
Aspen birch	Quaking and bigtooth aspen; paper birch; pin cherry; red maple; and gray birch.
Maple-beech-birch	Sugar maple; beech; yellow birch; elm; basswood; ash; northern red oak; black cherry; paper and sweet birch; and hemlock.

4-2.2. Central Region (fig. 4-1): The principal forest cover-type groups of the Central Region are—

Type groups and forest cover types	Principal associated species
Oak-hickory	Black, post, scarlet, chestnut, northern red and white oaks; hickories; black locust; maples; sweet gum; yellow poplar; beech, and black walnut.
Oak-pine	In addition to the above, shortleaf, pitch, white and Virginia pines; and eastern red cedar.

4-2.3. Southern Region (fig. 4-1): The principal forest cover types of the Southern Region are—

Type groups and forest cover types	Principal associated species
Longleaf-slash	Longleaf, slash, loblolly pines; bluejack, blackjack, southern red, laurel, willow and water oaks; sweetgum; hickories; black and tupelo gums; magnolia; red maple; and bay.
Loblolly-shortleaf pine	Loblolly, shortleaf, Virginia pines; southern red, black, scarlet, white oaks; sweetgum; hickories; red maple; and blackgum.

4-2.4. Western Region (fig. 4-1): The principal cover types are—

Egelman spruce—subalpine fir
Interior Douglas-fir
Ponderosa pine
Western White pine
Lodgepole pine
Pinyon pine—juniper

4-2.5. West Coast-Region (fig. A-1): The principal cover types are Sitka spruce, Western hemlock, Western red cedar, Pacific Douglas-fir-Western hemlock, Redwood, and Ponderosa pine—sugar-pine—fir.

4-2.6. Alaskan Region. The forest of Alaska (fig. 4-2) are divided into the coastal forest of southeast Alaska and the interior forest.

Figure 4-2. Forest regions of Alaska.

4-2.6.1. The coastal forest is similar to that of the West Coast Region. It occupies a mountainous belt of high rainfall about 50 miles wide from the coast to the Alaska Coast Region. The timber consists mostly of western hemlock and Sitka spruce. Fire occurrence is low. Regeneration is by clear cutting in blocks, leaving blocks of seed trees, without slash burning. Current harvests are of virgin timber; there are no young or middle-aged stands and partial cutting is impractical. The principal cover types are Sitka spruce, Western hemlock, Sitka spruce—western hemlock, and Western red cedar—western hemlock.

4-2.6.2. The interior forest is similar to that which extends across Canada. It is composed mostly of white spruce and Alaska white birch with black spruce and cottonwoods in areas of low rainfall and permafrost. There are scattered bodies of merchantable timber, but much of the forest is classed as unmerchantable due to the extensive destruction by uncontrolled fires. Markets for local use are developing slowly. Methods of management are not yet established. Principal cover types are White spruce, White spruce—birch, Poplar—birch, and Black spruce.

4-3. Silvicultural Practices.

4-3.1. General. Each forest type must receive specific silvicultural treatment. Lack of markets for some products, high logging costs, or large proportions of low value specifies, will restrict management practices. Thinning young hardwood stands for pulpwood is impractical in some areas because of poor markets, excessive costs, or unsuitable species. However, thinning young pine stands, is a profitable practice where pulpwood is in demand as in the Southern Region. Because of these differences, it is necessary to prescribe silvicultural practices in general terms. Develop locally in each forest management plan modifications suitable to the installation. The principal practices applicable to military forests are intermediate cuttings, harvest or regeneration cuttings, timber stand improvement, and reforestation.

4-3.2. Intermediate Cuttings. These are the removal of trees from a regular stand between the time of its establishment and the harvest cutting. It is sufficient here to recognize three types:

4-3.2.1 Thinning. A thinning is a cutting in an immature stand to increase its rate of growth, foster quality growth, improve composition, promote sanitation, and aid in litter decomposition (fig. 4-3).

4-3.2.1.1. Crown thinning. Remove the least promising dominants and codominants that are competing with more promising individuals of these classes. Few, if any, trees in the lower crown classes are merchantable, but the stand will stagnate or have a high mortality if not thinned.

4-3.2.1.2. Low thinning. This type anticipates natural mortality by marking from below. Remove overtopped trees having merchantable value as well as unpromising intermediates, lower grades of codominants, and others in order to provide better growing space for the remaining dominants and codominants.

Figure 4-3. Young Southern Yellow Pine stand after thinning.

4-3.2.1.3. Mechanical thinning. **Any** thinning that selects the trees to be removed according to some simple, objective criterion, e.g., a minimum spacing of stems gauged by a stick of predetermined length (stick thinning). In planted stands, alternate trees in alternate rows or every second, third or fourth row of trees may be removed.

4-3.2.1.4. ***Selection thinning.*** Remove dominants which show wolf-tree tendencies and overtopped trees which have a merchantable value. Do not remove choice clean, slender-stemmed trees that retain sufficient crown to continue into the dominant class (fig. 4-3).

4-3.2.1.5. ***Basal area thinning.*** Basal area is an expression of area in square feet of breast-high cross section for individual trees or for unit forest area (acre, hectare, etc.) Sound judgment and experience are the best marking guides. Keep the trees of good quality in the dominant position and utilize the growing space to its full potential. Maintain. basal area as recommended for the species. Timber markers may not readily visualize the basal area they are leaving and must check from time to time by use of the angle gauge or other device for determining the basal area.

4-3.2.2. ***Improvement cutting.*** Improvement cutting is made in a stand older than the sapling stage, usually to start improvement of wild stands being placed under management. It involves the removal of only those unwanted trees which are of sufficient size to provide the material for merchantable products. Types of trees removed in addition to undesired species include: diseased trees, those mechanically injured, unthrifty trees likely to die before the next cutting cycle, insect infested trees, and those of poor form (forked, crooked). Improvement cuttings and thmnings in a compartment are usually concurrent operations.

4-3.2.3. ***Salvage cuttings. These*** cuttings remove dead or injured trees to utilize them before they become worthless. Salvage timber promptly following storm blowdowns, ice damage, severe fires, or attacks of insects or diseases. If extensive areas are damaged, keep as seed trees those deemed most likley to live. It is often difficult to judge whether or not fire damaged trees will die, but in the South particularly, make the decision immediately after the fire.

4-3.3. ***Harvest cuttings. This*** is a general term for the removal of financially or physically mature trees

in contrast to cuttings that remove immature trees. Regeneration cuttings remove trees intended to assist regeneration already present or to make regeneration possible. There are four primary types of harvest cuttings:

4-3.3.1. Clear cutting. This is a technically sound, scientifically proven method for regenerating evenaged stands of timber. It may involve trees which are over-mature, diseased, or dying; or to change the species composition of the forest, or rearrange the age classes. Clearcut areas are regenerated either by natural or artificial methods. Clearcuts are usually limited in size to a maximum average of 50 acres each. They must be irregular in shape to provide optimum wildlife and other resources benefits, and should blend with contours and natural or man-made features.

4-3.3.2. Seed tree method. Seed tree cutting is the removal of all trees except for selected seed-producing trees of the featured species. Seed tree silviculture is of value on military installations when areas of forest must be cleared for use as new firing ranges and impact areas, motor parks, and bivouacs and the period of use may be for 10 years or less. Seed trees left during that period may produce seedlings of desired species which will result in a new timber crop after the period of other use is over. Seed tree value is indicated by the number of seedlings around a tree (fig. 4-4). The seed trees may be left standing singly, or in groups of 6 to 10 if soils or species favor windthrow. If groups are used, leave 4 to 8 groups per acre in trees 8 to 12 inches in diameter.

4-3.3.3. Shelterwood. The basic principle of the shelterwood system is the gradual removal of the timber crop by a series of partial cuttings over a period which is a fraction of the rotation, but long enough to obtain the desired reproduction. It is a modification of the seed tree method, using large numbers of seed trees rather than a few. Shelterwood is one of the more complex methods of harvest cutting and is best applied to even-aged stands. There are three stages to shelterwood harvest cuttings:

4-3.3.3.1. Preparatory cutting. To prepare for reproduction, cut below the dominant and codominant stand and remove 25 to 40 percent of the trees. The remaining trees grow better crowns and become more windfirm and decomposition of the litter is hastened. If cutting is too heavy, grasses and weeds may move in. The preparatory cutting (one or more) is unnecessary if thinning is practiced at regular intervals.

Figure 4-4. Longleaf pine seed trees.

4-3.3.3.2 ***Seed cutting.*** Make only one seed cutting **to** provide reproduction and remove 25 to 50 percent of the remaining stand. This cutting is made just after the seeds mature in a good seed year. Logging serves to work the seeds into the humus and mineral soil. Remove smaller trees, those of relatively low vigor, and those of very large size which would destroy too much reporduction if allowed to remain until the "removal cutting.*'

4-3.3.3.3 ***Removal cutting.*** This involves the remaining old trees in one or several operations, the last of which is the "final cutting" which may not be made for many years.

Note: Pure shelterwood does not provide the most ecnoomical processes of forest management. As the situation requires, combine the various steps each time a scheduled cutting cycle is marked.

4-3.3.4. ***Selection.*** This method calls for the removal, annually or periodically, of the trees which have reached rotation age. The theoretical selection forest is all-aged with proportions of each age class from 1 year old to rotation age. Actually, this condition seldom exists, but practical application of this type of cutting may be modified to fit local conditions. For best results, harvest cutting, thinning, and improvement cutting are combined in one operation. Each area is cut over once every cutting cycle. The openings made should be of sufficient size to meet the reproduction needs of each species.

4-3.4. Timber Stand Improvement. This is, broadly, the release of young trees of desirable species, generally under 4 inches DBH, from the competition of brush and overtopping by undesirable tree species. It differs from the other described types of silviculture in that the trees removed are unmerchantable for one reason or another.

4-3.4.1. Timing. Accomplish the work before the competition destroys the ability of the desirable trees to recover.

4-3.4.2. Types (or kinds). Timber stand improvement (TSI) is a term used to identify various silvicultural management practices designed to improve the vigor, stocking, composition, productivity, and quality of forest stands on military installations. These practices include:

4-3.4.2.1. Cleaning. A cutting made in a young stand, not past the sapling stage, for the purpose of freeing trees from other individuals of similar age but of less desirable species or form which are overtopping them, or likely to overtop.

4-3.4.2.2. Liberation. A cutting made in a young stand, not past the sapling stage, for the purpose of freeing the young trees from older individuals that are overtopping them.

4-3.4.2.3. Pre-commercial thinning. A thinning of a young stand where removed trees are not of operable value.

4-3.4.2.4. Release. A comprehensive term which includes cutting operations of the cleaning and liberation types.

4-3.4.2.5. Pruning. Good sites are a prerequisite for pruning. Trees in understocked stands and in plantations do not prune themselves as a rule. Those in dense stands prune naturally while the tree diameters are small. Pruning of small trees, whether naturally or by mechanical means, will improve the quality of timber produced. However, the expense is not justified for all species. Conifers that will produce high-quality products and a limited number of special product hardwoods may benefit from pruning. Hardwood limbs over 2 inches in diameter should not be pruned. High value in such species is usually associated with large size and clear wood (no knots). Such trees may require wide spacing and several prunings. Pruning should be limited to preselected final crop trees.

4-3.4.2.6. Sanitation. A cutting made to remove dead, damaged or susceptable trees essentially to prevent the spread of pests or pathogens and thus promote forest hygiene.

4-3.4.3. Procedure or methods of accomplishing TSI. Use the following procedures to control undesirable trees and vegetation.

4-3.4.3.1. Chopping. Useful when the tree, shrub or vine can be removed by less than four blows of a sharp ax. Include trees, shrubs and vines of larger diameter when chain saws are available. Followup treatment of the stumps with silvicide is desirable to control resprouting.

4-3.4.3.2. Girdling. Completely sever the bark and cambium layer and cut into the outer sapwood at least one-half inch for the purpose of killing the tree by preventing passage of nutrients or by admitting toxic materials. Girdling may also be done by:

4-3.4.3.2.1. Hacking or frilling. A single line of overlapping downward axe cuts, leaving a frill into which silvicides may be applied.

4-3.4.3.2.2. Double hacking. Girdling by means of a double frill cut around the tree and the removal of the chips between them.

4-3.4.3.2.3. Notching. Ringing the tree with notches cut or sawn well into the sapwood.

4-3.4.3.2.4. Stripping. Peeling off a band of bark completely around the tree.

4-3.4.3.3. Silviciding. Treatment using silvicides is more effective than girdling. Silvicides must be applied immediately after cutting for effective control of sprouting. Silvicides are pesticides and thus require application by certified personnel, or under their supervision. Observe strict safety precautions and clean equipment carefully after each use. Once equipment has been used to mix or dispense any of the chemicals, do not use it for any other purpose as even the best washing may not remove the chemical. The "Herbicide Manual for Noncropland Weeds" (app D, No. 2) provides guidelines for handling, mixing, applying and storage of herbicides. See appendix D, No. 4 and Chapter 11 and 14 of appendix D, No. 3 for container label, safety rules, and personnel certification requirements for compliance to EPA and state regulations. Consult the appropriate military command agronomist/forester or specialists from forest experiment stations, agricultural extension service and state forestry or environmental departments for specific current recommendations on chemical and rate of application. Some methods of applying silvicides are:

4-3.4.3.3.1. Basal. Application of granular herbicide at the base of trees, shrubs or vines, or liquid form usually mixed in diesel or fuel oil applied by low pressure sprayer (less than 30 PSI) completely covering the bark around the bole or stem and root crown to an 18 inch height.

4-3.4.3.3.2. Cut stump. Application as in paragraph 4-3.4.3.3.1. above of granular or liquid form to freshly cut stumps or stubs. Treatment immediately after cutting must be done for good control of sprouting.

4-3.4.3.3.3. Girdling. Application of liquid herbicide mixed in diesel or fuel oil to girdled trees, axe frills or hacks using squirt cans or low pressure hand sprayer.

4-3.4.3.3.4. Injection. Application of full strength or only slightly diluted herbicide through bark cuts into the sapstream of the tree using a tool such as a tree injector or hypo-hatchet. A series of injection cuts are made around the tree rather than complete girdling.

4-3.4.3.3.5. Mist blower. Application of low volume, high concentration herbicide spray mixture primarily for releasing conifers from competition of low value, undesirable hardwood species.

4-3.4.3.3.6. Aerial. Application of low volume, high concentration herbicide using specialized boom nozzle equipment attached to helicopter or airplane. Used primarily for release of conifers from competition of low value, undersirable hardwood species.

4-3.4.3.4. Prescribed burning. This is an economical procedure for reducing competition of undesirable broadleaved brush and tree species. Do not use it where hardwood species are the principal crop.

4-3.4.3.5. Mechanical. Use of a land clearing machine, brush chopper, pusher bar equipped tractors, and other equipment to mechanically thin or release selected crop trees in young dense stands, or planations, or unmerchantable size.

4-3.5. Reproduction.

4-3.5.1. Natural seeding. This is normally considered to be the most economical means of forest regeneration, if seed of the desired species is or will be abundant within a year or two of the time scheduled for establishment of reproduction. Most species do not produce a satisfactory crop of viable seed annually. If these variables plus loss of growth time can be tolerated, many of the coniferous species may be reproduced by natural seeding. Procedures will vary by species and geographical region, but the following guidelines may assist in successful regeneration:

4-3.5.1.1. Schedule a regeneration cut (seedtree or modified shelterwood) so that harvest is completed during the year of anticipated good seedfall, with sufficient time allowed so that seedbed is ready prior to actual seedfall.

4-3.5.1.2. Leave sufficient seedtrees per acre, in accordance with successful experience in the particular geographical area for the desired species (see paragraph 4-3.3.2., above).

4-3.5.1.3. Prepare seedbed as described below (Note : para 4-3.5.1.3.2. and 4-3.5.1.3.3. are common to southern pine stands).

4-3.5.1.3.1. Log with tractors so that skidding operations expose mineral soil to serve as a seedbed.

4-3.5.1.3.2. Burn the area to be regenerated just prior to logging to remove all excess litter, fuel, and debris. Usually this burning is accomplished during the winter prior to logging operations. This materially assists in insuring satisfactory scarification during skidding operations.

4-3.5.1.3.3. If the area has already been cut back to a seedtree or modified shelterwood stand, and small diameter undesirable hardwood species are invading, a hot prescribed fire during the summer period to seedfall may assist in reducing hardwood competition.

4-3.5.1.3.4. If the processes suggested in paragraphs 4-3.5.1.3.1. and 4-3.5.1.3.2. above are not feasible, disking the area with a tractor-drawn bush and bog harrow or rolling drum chopper may enhance chances for a successful seed catch. If the area has already been cut back to a seedtree or modified shelterwood stand, disking or roller-chopping should be done during the summer preceding a seed fall and final harvest cutting.

4-3.5.2. Coppice. This is a method of renewing the forest by sprouts. The value or importance of coppice as a method of forest regeneration has been traditionally underestimated. Much of the hardwood natural regeneration in eastern forests is by sprouting. Single sprouts originating from small stumps are often mistaken for seedling origin. Therefore, in some comparisons of sprouts versus seedlings, the best sprouts may often be erroneously considered seedlings. Stump sprouts have been associated with butt rot resulting from decay of the parent stem. Sprouts originating high on the stump are susceptible to butt rot. This problem is reduced by improved timber harvesting practice that leads to lower stump heights and a decrease in the high origin sprouts. Also, increased intensity of forest management includes thinning sprouts at an early age and eliminating the high origin sprouts. Coppice for applicable species should be considered with other regeneration alternatives.

4-3.5.3. Planting. Artificial regeneration of stands by planting of forest tree species is considered to be the most feasible method of: insuring adequate regeneration; determining species composition; controlling stand density; and insuring immediate restocking of depleted areas resulting from such causes as wildfires, or areas cleared for military use and subsequently abandoned. The use of genetically superior planting stock permits wider spacing of seedlings, which results in a forest environment more compatible with military training; provides a generally more productive wildlife habitat; permits prescription burning where applicable at an earlier age; and produces more rapid tree growth.

4-3.5.3.1. Restrict planting to lands that do not

exhibit adequate natural stocking or which have been so extensively invaded with advanced reproduction of inferior species that natural regeneration of desirable species is not feasible or too costly.

4-3.5.3.2. Plant lands that are suitable for the growing of commercial timber, and not required solely for incompatible military use (e.g., tank parks, firing ranges, outdoor classrooms, etc.) Abandoned impact areas must be decontaminated prior to planting to insure safety of planting personnel and subsequent users of the area(s).

4-3.5.3.3. Soil-site factors and suitability must be carefully evaluated when planning an area for planting. Species selected for planting should have commercial value, be native to the region, and respond satisfactorily on the site(s) planned for reforestation. Introduction of exotic species, ornamentals, or species not suitable for commercial purposes is not compatible with the goals of the military forest management program.

4-3.6. Reforestation Procedures.

4-3.6.1. Site Preparation. Principles governing site preparation in advance of planting will vary from site to site and region to region; however, the most recent research findings indicate that better survival and growth of forest tree seedlings has resulted where the least possible preparation has been accomplished. Massive land clearing, to include stumping and grubbing, is neither economical nor necessary for reforestation. Preparation should be programed to allow for either hand or machine planting, whichever is the usual practice in the region. Soil displacement and translocation should be minimized. All that is usually necessary is to reduce overtopping or competing vegetation and leave the site in a plantable condition. Larger residual stems take up less room standing than when felled or pushed, and will provide nesting and food for game and non-game birds, even if later deadened in stand improvement operations.

4-3.6.1.1. Little or no preparation is required before planting abandoned fields and similar open areas, unless tall grasses and dense underbrush are present to interfere with planting machinery, or will reduce survival and growth. Remove interfering material by burning with a hot fire, prior to planting. Take precautions as for any prescribed burn.

4-3.6.1.2. Where brush is of a size or density to preclude sufficient reduction by fire, mechanical preparation is necessary. Several options are open for use, depending upon terrain and vegetation characteristics. In the Southeast, for example, excellent results are obtained with the heavy rolling drum chopper, which consists of a water-filled steel drum 7 to 14 feet long, 2 to 6 feet in diameter, and equipped with 10 to 15 sharp blades attached around the circumference of the drum. This machine is towed behind a heavy crawler tractor. A tractor blade pushes the brush and small trees over, the rolling drum chopper breaks and tears up the stems, leaving them in place on the ground. The drum chopper does not scalp the soil or result in any major soil movement or disturbance. It is not effective on stems over 5 inches in diameter.

4-3.6.1.3. Blading, shearing and windrowing or piling may be used on areas occupied by large diameter stems. The hydro-axe and mechanical tree chopper may be used where tree stems do not exceed 12 inches in diameter. Ordinary bulldozer blades may be used where the trees are scattered; however, this is not a satisfactory method where a large number of stems are encountered. In such cases the stump as well as the stem is removed, creating a disposal problem, and displacing considerable top soil. Specially designed shearing blades sever the stem at the ground line without pulling the stump and root system. This material is readily raked into windrows or piles. Only root rakes should be used for windrowing or piling, as this minimizes soil being incorporated into the windrow, results in a more compact pile or windrow, and reduces acreage lost to planting. In hilly or rolling areas, windrows should be located along the terrain contours to preclude erosion problems.

4-3.6.1.4. Heavy-duty bush and bog harrows may be used in some areas with success; however, before the area is planted, a period of several months should elapse to allow the soil to settle back to normal compaction. At least one mechanical cutter is available which features a "V" shaped blade that travels eight to ten inches underground to sever stems, followed by a bush and bog harrow section which stabilizes the blade and does some tearing and chopping of roots. This equipment produces satisfactory results in sandy soil supporting small scrub oak, but it leaves the area in rough condition, making machine planting difficult.

4-3.6.1.5. Areas treated with a rolling drum chopper usually can be burned shortly after chopping. This further reduces debris which interferes with planting equipment and helps kill or set back undesirable stems. Chopping is best done in the late spring, followed by burning in the hottest part of the summer (wildlife considerations could delay this action by 2 to 3 months). Unless windrows occupy excessive acreage, they should not be burned. This unburned debris provides excellent wildlife habitat and cover. Clean air regulations prevent open burning of debris in many locations.

4-3.6.1.6. Badly eroded or erosive sites, such as new cuts, fills, borrow areas and dunes, must be stabilized before reforestation. A good grass cover will accomplish this in most cases. After area is stabilized, tree seedlings may be planted. Machine

planting should be done with the contours to prevent further erosion. Grassing operations are not normally within the purview of reimbursable forestry operations.

4-3.6.1.7. Site preparation using specialized equipment normally lends itself better to contracting than accomplishment by in-house personnel, the exception being small scattered areas which do not lend themselves to satisfactory contracting operations.

4-3.6.2. When to plant. The planting season varies with the different regions and even within regions of the country. Normally planting is accomplished while the stock is dormant, or not later than when just starting new growth. Soil conditions must be favorable, and not excessively wet, dry, or frozen.

4-3.6.2.1. In the West, plant in the spring and continue as long as soil moisture and condition of the stock permits.

4-3.6.2.2. In the Central and Northern Regions, plant from 1 March, if ground is thawed completely, and continue to approximately 1 May.

4-3.6.2.3. In the Southern and Southeastern Regions, start planting as soon as seedlings are available from nursery sources, around 15 November if soil moisture is adequate. Planting should be completed by start of growing season for best results.

4-3.6.3. Planting stock. Use the kind, size, and age of stock best suited to local sites and climate. Seedlings are available from State Forest Service nurseries. Seedlings should be obtained from the State nursery nearest the planting sites. Geographical seed source should be included in any planting contract in order to insure that seedlings are locally adapted. Wild seedlings dug from nearby woodlands should not be used. This practice is very costly and the results are unsatisfactory. One-year-old seedlings, identified as 1-0 stock are normally used in the Southeastern States. In other areas, seedlings two or more years old (2-0, 3-0, etc), or transplants (1-2, 2-1, 2-2, etc) may be necessary, as is standard with regional use practices. Other things being equal, the older the planting stock, the higher the cost.

4-3.6.3.1. Protect planting stock in transit against overheating, dehydration, breakage, and freezing. This responsibility should be clearly spelled out in any planting contract. Normally, the planting contractor makes his own arrangements with the State nursery for obtaining seedlings. Some installations may find it advantageous to furnish the seedlings; in this case, it is the responsibility of the installation to properly transport and store the seedlings.

4-3.6.3.2. Storage instructions are normally provided by the nursery, and should be followed diligently to prevent losses from overheating, drying out, freezing, or other causes. Some nurseries use bundles which are open at the top, and these may be watered periodically. Others use sealed polyethylene lined kraft bags—care must be taken in handling to prevent tearing. Kraft bagged seedlings normally do not require watering, but seedlings must be planted within the time specified on the delivery ticket. Bags should be carefully inspected, and any found torn should be checked for dehydration; dry seedlings should be immediately discarded. If contents are not dried out, seedlings may be watered in the bag and the hole(s) secured with masking tape. If weather conditions (freezing, extreme drought, etc) preclude planting within the time specified on the delivery ticket, seedlings should be removed from bundles and properly heeled in a watered V-trench that is deep enough to permit covering the roots without curling them. When planting starts, it is imperative that the roots of seedlings be kept continuously moist with wet moss, water in buckets or planting trays, or otherwise prevented from drying out. Exposure of seedling roots to the air for as little as 1-2 minutes can render the seedling unfit to plant.

4-3.6.4. Planting procedures

4-3.6.4.1. Machine planting is the fastest and most economical means of planting seedlings, and lends itself well to contract projects. In-house personnel planting should normally be limited to small, scattered areas. This is especially true in the Southeast, where the planting season occurs when the forest fire and prescribed burning workload are at their peak, and forestry personnel cannot be committed to reforestation activities on a fulltime basis.

4-3.6.4.2. Hand planting with a planting bar (dibble), mattock, or grubhoe must be used if topography is too rough or rocky for machine planting. Hand planting is also useful for filling in areas skipped by machines, and must be used for certain high value species, such as black walnut, where survival of each tree is important. The following guidelines should be followed for hand planting:

4-3.6.4.2.1. Dig the hole deep enough to prevent bent or doubled roots (J-rooting).

4-3.6.4.2.2. Set at the same depth that the seedling grew in the nursery, i.e., with the root collar at the ground line.

4-3.6.4.2.3. Pack the soil firmly around the roots while holding the seedling in an upright position with respect to the surrounding ground level, and be sure all air pockets are eliminated.

4-3.6.4.3. Planting should allow each seedling a minimum growing space of 60 to 90 square feet, with space enough between the planted rows to drive a log truck, fire equipment, allow for subsequent cultivation for wildlife feed strips, etc. The current trend especially in the Southeastern Region is toward wider spacing between rows. This provides a faster product return, earlier prescribed burning, better access for fire control and mechanized logging equipment. Side benefits from wider spacing include more desirable wildlife habitat, and better military field training environment. The following chart indicates the number of trees required for different spacing configurations. Most state nursery tree counts are based upon sampling to establish a liberal seedling weight ratio; therefore, the actual number of seedlings received will probably be more than actually ordered, and no percentage add-on is required:

Space of plants	*Trees per acre*	*Square feet/tree*
6 ft. in rows 10 feet apart	726	60
6 ft. in rows 11 feet apart	660	66
7 ft. in rows 9 feet apart	691	63
7 ft. in rows 10 feet apart	622	70
7 ft. in rows 12 feet apart	518	84
8 ft. in rows 8 feet apart	680	64
8 ft. in rows 10 feet apart	545	80

4-3.6.5. Direct seeding. Direct seeding of forest tree species on military reservations has met with varying degrees of success, ranging from excellent to total failure. Soil-site relationships are more critical than with planting, and the variables of drought and excess rainfall during the sowing period have a more devastating effect. The greatest advantage to direct seeding is a much lower cost per acre, especially where large areas are involved. In the event of total failure, the area may be seeded a second and possibly a third time before per acre cost equals or exceeds planting costs. It must be considered; however, that a failure also results in a 1 year loss of growth, and may add the requirement of site re-preparation, with a corresponding increase in cost. Direct seeding should be considered only after weighing all variables. Consult with the nearest Forest Service Experiment Station, the state Forester and commercial forest managers who have met with consistent success, to obtain the latest recommendations. Compare their site relationships to the installation situation before proceeding. The following general guidelines will apply:

4-3.6.5.1. Obtain fresh tested seed from a reliable source, with the specification that it must be treated to repel rodents, birds, and insects. Request the nearest Forest Experiment Station or State Forest Seed Laboratory to provide their latest recommendations for developing contract specifications. Seeds of some species may need refrigerated storage. Seeds subject to delayed germination (more than 14 days) may need to be soaked, stratified, scarified, or acid-dipped. Requirements for specific species will be covered in detail in research papers. In some cases, such as black walnut, adequate seed sources may be available on the installation, and although these trees from old homesites are not necessarily genetically superior, they may provide an adequate supply of seed for limited local use. Black walnut seed is heavily susceptible to pilferage if planted in the fall, but may be stratified during the winter in a sawdust pit, and set out in the spring just as the nuts begin to sprout. Again, consult with a reliable source on proper procedures.

4-3.6.5.2. Distribute the seed over the area by one of the following methods:

4-3.6.5.2.1. Hand broadcasting is suitable for very small areas only. It is the most expensive method since distribution is uneven and more seed than necessary is used.

4-3.6.5.2.2. Cyclone type agricultural seeders are economical for areas of 10 acres or more. Speed of travel and spacing are predetermined by calibration trials in order to space the desired number of seed evenly over the prepared ground.

4-3.6.5.2.3. Aircraft (fixed or rotary wing) for direct seeding may be available on the installation, or by contract from agricultural flying services (crop dusters and commercial seed applicators). For large prepared areas, this method is the cheapest on a per-acre-basis; approximately 1000 acres can be seeded per day. The installation may have to provide ground personnel under the terms of the contract.

4-3.6.5.2.4. Seed drills are practical where soil and terrain will allow tractor travel in a safe unimpeded manner. With this type of equipment, the seed is planted in shallow plowed furrows based on calibration tests or reference charts available from local experiment stations.

4-3.6.5.3. The rate of application will vary species by species, according to the number of seed per pound, and germination percentage. Typical application rate for aerial seeding of longleaf pine would be 3 pounds per acre, with an average seed count of 4200 clean seed per pound, or 12,600 seeds per acre. Douglas-fir, on the other hand, contain approximately 42,000 seeds per pound. It is imperative, therefore, to consult proper technical sources for data applicable to the species and site.

4-3.6.5.4. Seeding must be done during the proper season for the climatic zone and according to the tree species used.

4-3.6.5.5. Pines and seeds of a similar size shold be covered to approximately 1/8-inch. Heavy seeds, which are dibbled in individually, such as acorns and

walnuts, should be planted at a depth equal to the width of the seed being planted.

4-3.6.6. ***Performance rates.*** As a basis for calculating labor and equipment requirements for planting, estimate 300-500 trees per man-day in holes in clay soils and on rough or rocky steep terrain, 800-1000 trees per man-day on sandy soils and level land, using hand labor. Machine planting with tractor-drawn planting machine of medium to heavy-duty size will average 1500-2000 trees per machine-hour. Use of small crawler tractors equipped with a "V" pusher (fig. 4-5) will materially assist in maintaining an adequate performance rate and insure better planting results. The use of "V" pusher should be specified in all contracts where machine planting will be done on other than open abandoned fields where no prior preparation, other than burning of grass is required.

4-3. 7. ***Tree Classification.***

4-3.7.1 Hardwoods are native trees that have broad leaves and, generally shed their leaves prior to each growing season. Examples: oak, ash, maple, magnolia, elm, hickory, and aspen. The term has nothing to do with the physical hardness of softness of the wood.

4-3.7.2. Softwoods are known also as conifers. All native species of softwoods have needlelike or scalelike leaves and bear their seed in cones. With the exception of two genera, Larix (larch) and Taxodium (baldcypress), softwoods are "evergreen."

4-3.7.3. Old growth refers to trees and stands that have reached or passed maturity. In addition to age and size, the principal characteristic is relatively slow growth due to intense competition for sunlight andmoisture.

4-3.7.4. Second-growth trees and stands are those that have come up naturally after some drastic interference (e.g., wholesale cutting, serious fire, or insect attack) with the previous forest crop.

4-3.7.5 Crown classification is valuable as a gauge of silvicultural behavior and the current position of trees in the stand. The following system distinguishes the seven classes which are standard for all Department of Defense military reservation timber:

4-3.7.5.1. Dominant trees extend above the general level of the canopy.

Figure4-5. V-pusher equipped tractor with heavy duty tree planter attached.

4-3.7.5.2. Codominant trees are not as tall as the dominants, but receive excellent overhead light, have full crowns, vigorous growth, and show no danger of being crowded out by the dominants.

4-3.7.5.3. Wolf trees are distinguished by a widespreading crown that occupies more than its fair share of the growing space, and limbs that are relatively larger and often more numerous. The lumber quality of the stem is poor to unmerchantable because of the large knots resulting from the many oversized limbs.

4-3.7.5.4. Intermediate trees have slender crowns that occupy smaller openings in the canopy, receive only a limited amount of direct sunlight, and will probably be crowded out by the dominants or codominants before reaching maturity unless released by death or removal of the dominating trees.

4-3.7.5.5. Suppressed trees are definitely below the general level of the canopy and receive no free overhead light. These trees will die before the end of the rotation, or will remain stagnated making no appreciable height or volume growth.

4-3.7.5.6. Isolated trees stand at a distance from other trees, have a greater height than the average dominant, and are not properly classified as wolf or reproduction.

4-3.7.5.7. Reproduction is a naturally established tree seedling or sprout having a diameter of less than 2 inches DBH and an age of less than 30 years.

4-3.7.6. Age classification is useful in type mapping (pure stands are frequently typed by age classes), volume table construction, and reports. Examples of age classification classes are—

Inclusive ages	Age classification
0–10	5
10–20	10
20–30	20
30–40	30

4-3.7.7. Diameter classification is useful for volume table construction, development of fire damage tables, stand descriptions, and other purposes. For example, volume tables are usually developed by 1- or 2-inch-diameter classes. The 1-inch classes are generally 4, 5, 6, and up with each group including all trees having diameters, inclusive, of 3.6 through 4.5, 4.6 through 5.5, and so on. The 2-inch classes are generally 6, 8, 10, 12, and up, with each group including all trees having diameters, inclusive, of 5.1 through 7.0, 7.1 through 9.0, 9.1 through 11.0, and so on.

4-3.7.8. Form class is based on diameter breast high (DBH), total height, and taper of bole. It is desirable to classify trees according to form in order to develop greater accuracy in volume tables. Theoretically, all trees of like form class should contain the same volume, regardless of species or locality. In practice this is not quite true due to differences in volume resulting from the kind and degree of utilization (sawtimber or pulpwood, and varying top utilization diameter) and type of volume table desired (board foot, cubic foot, peeled cord, or rough cord). Volume tables based on form class are in widespread use.

4-3.7.8.1. Computation. Form class is expressed as the percentage ratio between the diameter, inside bark, at the top of the first 16-foot log; and the diameter, outside bark, at breast height (DBH). For example: a tree whose first 16-foot log has a scaling diameter (inside bark) of 15 inches and a DBH of 18 inches has a form class of $(15 \div 18) \times 100$, or 83.3 percent, which in practice is referred to as "form class 83."

4-3.7.8.2. Minimum form class. Form class below 65 should be considered for uses other than lumber production. Swell-butted species, such as cypress and tupelo, will have a very low form class based on DBH. To avoid this, the diameter of swell-butted trees should be measured high enough on the tree to provide a realistic form class.

4-3.7.9. Botanical Classification. Trees may have more than one common name, varying with locality. "Pitch pine" may be coulter pine in California, slash pine in South Carolina, or longleaf pine in Louisiana. To avoid confusion and insure accurate identification of trees and other vegetation, scientific names have been assigned to each species and variety together with standardized common names for everyday use.

4-3.7.9.1. The scientific name has two or more parts: First, the generic name; second, the specific name. Sometimes it is necessary to add a varietal name. The generic name is always written first and is capitalized. The specific and varietal names usually being with small letters. For example: all true maples have the generic name *Acer.* The specific name for sugar maple is *saccharum.* These two words, *Acer saccharum,* identifies it as sugar maple.

4-3.7.9.2. See appendix D, No. 1 for "Check List of Native and Naturalized Trees of the United States."