Planting and Care of Fine Hardwood Seedlings

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Planning the Tree Planting Operation

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Why Plant Trees?

Before going to the trouble and expense of installing a tree plantation, it is important to establish one's motivation. Hardwood plantations are unlikely to yield what many consider to be a reasonable rate of return on their investment in the short term. In addition, not all sites are suitable for growing fine hardwoods. Nevertheless, even if a parcel of land is not ideal for producing wood products (veneer, dimensional lumber, fuel, or fiber), forest cover can still provide other benefits. The reasons are varied, and can include wildlife habitat (for hunting, observation, or altruistic purposes); aesthetics; clean air and water; erosion control; an enjoyable hobby; to leave a positive legacy; or enrollment in a cost-share program (MacGowan et al. 2001). Cost-share program requirements may at least partially determine one's objectives (stocking levels and other restrictions). Given all of this, the landowner must be realistic when deciding whether a site is capable of meeting his or her goals. This publication will primarily address small, private landowners planting on land that has previously been used for agronomic crops or as pasture; agroforestry, the development of riparian buffers, etc. are covered elsewhere (e.g., Grala and Colletti 2003; Schultz et al. 1995).

Importance of Planning

The first three to five years are critical to the success of any plantation. Primary reasons for tree mortality include: a species-site mismatch, poor site preparation, competing vegetation, animal damage, and low seedling quality. Good planning also improves the chances of meeting landowner objectives by making subsequent treatments easier to accomplish. Therefore, planning should commence at least 12 months before the start of planting. This is especially true for cost-share programs, the requirements of which may affect the timeline and the treatments that can be applied. As part of the planning process, one must select a planting scheme. Some growers prefer the "row-crop" approach to stand management, where trees are planted in pure stands, aligned in straight evenly spaced rows, using a fixed distance between trees within a row. In this case, competing vegetation is often controlled meticulously by directed or sheltered applications of herbicide. Alternatively, a species that provides ground cover (e.g., a shrub or small tree layer) can be used to control weeds, and may provide an insulative layer to prevent frost cracks and heaving. Moreover, the plant cover may be beneficial for wildlife, particularly if it produces a "stair step effect." Although silvicultural operations vary with the type of planting scheme chosen, the planning process is similar for all planting designs.

Figure 1. *Example of a machine planting operation on a level site. (Photo courtesy of Douglass F. Jacobs)*

Site Inspection

Apart from climate and topography, soil properties (e.g., depth, texture, drainage, and nutrition) are the most important site characteristics to consider. Collectively, these factors dictate the tree species that a given site will support. Such variables are discussed in another publication by Ponder and Pope (2003). It is advisable to examine the site for any pre-existing features that could be problematic. These may include plow pans; surface erosion; and changes in hydrologic conditions, such as a water table that is altered after the removal of previous cover, the presence of drainage tiles, blockage of natural drainage, or susceptibility to flooding. In addition, rocky soils may preclude the use of a planting machine (Fig. 1). During this site inspection, determine how many pre-planting tasks will be required. For example, it may be necessary to remove any existing vegetation through cultivation or herbicide treatment, or both. Other potential site-specific problems could include: insects and diseases, access control, usage of adjacent land (e.g., complaints of pesticide drift), and herbicide carryover from the last crop that might injure or kill the trees. Poor site preparation is one of the key reasons for plantation failure.

Figure 2. *Range in quality of seedlings, all of which are the same age. (Photo courtesy of Douglass F. Jacobs)*

Making a Plan

The planting plan should include details of all treatments, from initial site preparation to at least three to five years after planting. Following the inspection, the next decision is what trees to plant — a single species or a mixture. If the latter, what combination will be used? In the Midwest, we are losing our hard mast species, such as oaks, which are an important food source for wildlife, because we are harvesting these trees faster than they are being regenerated. A key problem is that the seeds are heavy, so carriers are needed for long-distance transport. These species also grow slowly and are generally shade-intolerant, so they do not compete well against other woody perennials. In contrast, light-seeded species, such as yellow poplar (*Liriodendron tulipifera* L.), boxelder (*Acer negundo* L.), or red maple (*A. rubrum* L.), tend to be early-successional, and can disperse their propagules over great distances. Thus, to achieve a good mixture, it is best to plant heavy-seeded trees at a high density and let the wind blow in the light-seeded species that vigorously regenerate themselves naturally. If this approach is used, it is vital to anticipate natural selection. (Competition from trees established by wind-blown seed is greater because they tend to grow faster.) Alternatively, one may choose to plant a single species.

Once the species composition is decided, the planting layout must be considered. Depending on how intensively managed the plantation will be, there may be a need for repeated re-entry (for weed control, pruning, pest management, or pre-commercial thinning). If trees are planted in straight rows, the alleys must be wide enough to accommodate equipment for these various silvicultural treatments. If the site is going to be fenced, sufficient room should be left at the ends of the planting rows for equipment to turn around. If trees are spaced randomly, roads or trails may be necessary.

Planting density and, therefore, average spacing, will not only affect maneuverability, but will also influence tree quality (see below). Equipment access is generally not as important later in the rotation. If the topography does not preclude its use, then another decision to make will be whether to plant up and down the slope or along contours.

The success of any planting operation depends on the quality of planting stock used (Fig. 2). It is essential to locate a nursery that can supply seedlings of a suitable species, seed source, age, size, nutritional status, and Shoot:Root ratio (S:R). It is also important to verify the nursery's storage capabilities, their method of shipping, if seedlings can be delivered on the date(s) specified, and the deadline for placing orders. It might also be useful to determine the possibility for substituting a species or postponing a shipment if there is an unforeseen need to alter or delay implementation of one's planting plan. Planting time is a critical consideration; it is crucial to have sufficient moisture in the soil to ensure seedling survival and rapid early growth, and to avoid frost damage (Seifert et al. 2006).

Site factors, weather, and stock type may influence the planting method. If the slope is too steep or the soil is excessively rocky, it may not be possible to utilize a planting machine. Certain soil types are also susceptible to compaction when wet. Many growers prefer taller planting stock, so trees can get above the deer browse line sooner. However, large seedlings often have a high S:R ratio, resulting in insufficient absorption capacity to satisfy the transpirational needs of the seedlings, thereby impacting survival and growth. Moreover, planting machines may not accommodate bulky seedlings. Although dibbles can be used with smaller, containerized stock, they are not useful for large, bare-root hardwood seedlings. Other hand tools, such as a hoedad, planting bar, or shovel, are effective, but require more effort and time. Absent any site limitations, estimating the time required for hand planting and considering the prevailing hourly wage may make the choice of planting method obvious.

Recent work has shown that seedling survival is highest on sites that have been mechanically planted and receive chemical treatment to reduce competing vegetation (Jacobs et al. 2004). Although applying the latter during or near the time of planting adds to the initial expense, it may dramatically affect survival and early growth, reducing or obviating the need for inter-planting or replanting. Some growers incorporate a pre-emergent herbicide, systemic pesticides (insecticide or fungicide), and a slow-release fertilizer in the planting hole or trench.

In addition, deer browse is a serious problem in many parts of the country, especially in the Midwest.

Depending on the severity, herbivory can lead to everything from malformed trees to total plantation failure. Although various types of repellants are available, they are expensive to purchase and apply, and are usually only marginally effective. Protective stem sleeves can be used, but add considerably to the overall cost (materials plus the labor associated with installation and removal). Estimating growth rates allows one to predict when seedlings will be free to grow, which influences the decision about the need for such protective measures.

Finally, it must be decided if professional assistance will be used for either planning or executing the field operation. Realistic estimates of the workload will be needed to inform the decision-making process. Whether the landowner wants to employ an individual, or chooses to hire multiple contractors to perform different aspects of the project, it will be necessary to decide who will do what, and when, to ensure nothing is overlooked. For example, who will order the seedlings — the landowner or the planting contractor? If it is the contractors, the landowner is advised to obtain several bids for the same work.

Silviculture

Landowners should anticipate all the silvicultural treatments that will be needed throughout the life of the plantation, then generate a timetable indicating what will be done and when (Table 1). Below are examples of what should be considered.

Although it is difficult to quantify, trees grown in mixed plantings (in an effort to imitate nature) are nearly always superior in quality to those grown in monocultures. Regardless of whether a single species is planted in evenly spaced rows or a mixture of species is planted at non-uniform spacing, it is worthwhile to include “nurse” trees to “train” your crop trees. Some growers achieve this by planting a single species at a higher-than-desired density (Fig. 3). The tradeoff is, that while those extra trees minimize the need for replanting, which is expensive and time-consuming, it necessitates thinning later. Dense plantings encourage good tree form and allow for early canopy closure, thus reducing the need for vegetation management, because weeds are generally shade-intolerant species. Nevertheless, it is imperative to have good weed control until canopy closure is achieved. The greater number of stems also provides for a wider range of potential ‘crop trees’ during later selection. If high densities are used, it is important to thin trees at the appropriate times to prevent growth stagnation. It is recommended to limit spacing to no more than eight to 10 feet within a row and adjust spacing between rows to accommodate equipment access, if this is part of the plan.

Figure 3. *A high-density red oak plantation. (Photo courtesy of Douglass F. Jacobs)*

Other growers attain this higher density by surrounding their ideally spaced, commercially important species with less desirable (and, therefore, cheaper) species (either tree or shrub) for training and weed-control purposes. Depending on how shade-tolerant the cover crop is and how fast it grows, it may be necessary to prune or remove it later to prevent excess competition. For example, if one plants a 50:50 mixture of yellow-poplar and northern red oak (*Quercus rubra* L.) and does not eventually remove the poplar, a vigorously growing oak stand will never be achieved. Alternatively, one can inter-plant Scots pine (*Pinus sylvestris* L.), which, if harvested for Christmas trees, can be sold to recover some of the establishment costs (Fig. 4). Even if it is not removed, this pine is so shade-intolerant that it will die once it is overtopped by the hardwood tree species. Inter-planting a variety of fine hardwood species instead can also be a hedge against the vagaries of changing consumer tastes. It is difficult to predict future markets; one species not commercially valuable today may become valuable in the future as preferences change. No matter how it is

Table 1. *Timeline for major planning and tree planting activities.*

Action	Timing
Site inspection	Beginning of previous summer
Consulting with qualified forester	Beginning of previous summer
Developing planting plan	During previous summer
Site preparation (clearing and weed control)	Fall of previous year
Ordering seedlings	By October 15 of previous year[1]
Canceling seedling order	By March 1 of planting year
Changing seedling order	By April 1 of planting year
Planting and additional weed control	April to May
Continuing weed control	Spring every year for three years[2]
First pruning	10 years post-planting
First commercial thinning	15 years post-planting

[1] For example, see: http://www.in.gov/dnr/forestry/index.html?http://www.in.gov/dnr/forestry/nursery/&2

[2] Some silviculturalists recommend five years of weed control, but three is more common when considering costs vs. benefits.

Figure 4. *A site on which oak and pine were interplanted to encourage better hardwood tree form. (Photo courtesy of Douglass F. Jacobs)*

accomplished, shading the trees at the side is important for producing straight boles; this "funnel effect" forces the crop trees to grow up, not out. Thinning is important for other reasons. For example, thinning black oak (*Q. velutina* Lam.) planted on sites with sandy soils will result in better survival and faster growth because of less competition for moisture. In some cases, the thinning of hardwood species will result in the proliferation of stump sprouts or root suckers. This defeats the purpose of thinning (i.e., to reduce the number of stems per acre). For remediation, some growers "paint" the stump with a systemic herbicide immediately after the tree has fallen. This can be problematic with species that are capable of forming root grafts because the herbicide may be transmitted to uncut trees via a vascular connection. Depending on the species and the concentration of the herbicide used, this could result in even fewer stems per acre than anticipated.

The need for other silvicultural treatments will depend on the species planted and the purpose intended. For example, if trees are being grown for veneer logs, pruning may be needed, particularly at wider spacings. Even species and genotypes that are ordinarily capable of self-pruning will not do so when they are open-grown. Moreover, pruning may need to be done in phases because removing too much of the live crown all at once can have detrimental effects on growth.

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