Planting and Care of Fine Hardwood Seedlings

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A Guide to Legal and Genetic Terminology Used in the Sale of Hardwood Seeds and Planting Stock

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Paying a premium for better genetics is not new to agriculture or to forestry in some parts of the United States, but paying a premium for genetically improved hardwood trees is new for most consumers. Genetic improvement efforts for hardwoods, especially in the Midwest, have been relatively modest and slow to produce marketable products. However, both public and private nurseries are beginning to sell limited quantities of hardwood seeds, seedlings, and grafted trees variously labeled as "genetically improved," "improved," "genetically enhanced," "superior," and "select." Items labeled with these terms usually command higher prices than common planting stock.

Landowners in Indiana plant millions of hardwood seedlings each year. Most of these seedlings are planted as 1-0 bare-root stock (Fig. 1). Landowners thinking of investing in planting stock that is sold with an implied assurance of superior performance need information to make informed decisions about the value of these products. This publication describes the laws that apply to those who purchase seeds and nursery stock and explains the methods used by tree breeders to improve trees. This information should help consumers judge the value of the trees they purchase.

Legal Protection for Consumers[1]

Consumers who purchase hardwood seeds, seedlings, own-rooted trees, or grafted stock from public agencies or private vendors are protected by the prevailing consumer protection legislation in their state, by any contracts or warranties that may be offered at the time of sale, and by other provisions of state law such as licensing requirements. If consumers purchase nursery or seed stock from a state other than the one in which they reside, they may also be protected by certain federal statutes and codes. The propagation and sale of some nursery stock may be protected by trademark or patent laws, but these laws affect nurseries more

Figure 1. *Typical 1-0 bare-root nursery stock ready for planting. (Photo courtesy Douglass Jacobs)*

than consumers. The pertinent laws and licensing requirements vary from state to state. Before investing in hardwood planting stock, consumers should determine what protections are available to them in their states.

Hardwood seeds. States in the Central Hardwood Region have enacted specific statutes called Seed Certification Laws that regulate the sale of seeds (Appendix 1). The goal of seed certification is to assure consumers as to the identity and origins of the seeds they purchase. Hardwood seed is rarely certified at the present time. Generally, seed certification is a voluntary program. Certification of identity (and sometimes quality) is provided by an independent agency for a fee paid by the producer (Mangold and Bonner 2006). Seeds or the plants grown from them that have been certified are sold in

Figure 2. *Tag for seed certified by Wisconsin Certified Seed Association. (Image courtesy Wisconsin Crop Improvement Association)*

containers bearing official certification tags (Fig. 2). The tags identify the certifying agency, and they also indicate to which of three classes the seeds or seedlings belong; seeds can be **source-identified**, **select,** or **certified**. In general, only **certified** seed is from trees with proven genetic superiority, but the details of certification vary from state to state. For details, consult with the certifying agency in your state (Appendix 1). Seeds sold without this type of certification are not covered by legal guarantees of genetic quality or performance.

Hardwood seedlings and other nursery stock. Nurseries that sell hardwood seedlings and other types of nursery stock are described by legal terms that indicate their status, and the status of their products, under the law.

Registered. The business has registered with the State to conduct business and collect taxes.

Licensed. Usually refers to a firm that has obtained a license from the state to operate as a nursery or dealer, and places itself under regulation by the state. Usually states inspect nurseries to be certain their stock is free of certain pests and diseases, and that it is likely to grow and survive.

Certified stock. All nursery stock must be certified. In Indiana for example, certification means that the stock has been inspected, complies with state rules, and is free of certain diseases and pests. Certified stock is not the same as certified seed. *Certified stock* may or may not have been grown from *certified seed*.

Nursery certification is a voluntary process by which nurseries join together to agree on best practices.

Containerized Trees. The Uniform Weights and Measures Law and the Uniform Packaging and Labeling Regulations are overseen by the National Conference on Weights and Measures (NCWM; http://www.ncwm.net). The NCWM interacts with industry groups through the National Institute of Standards and Technology (NIST). The NIST has developed a set of voluntary guidelines for the marketing and labeling of plants in containers. These guidelines are found in NIST Handbook 130, "Uniform Regulation for the Method of Sale of Commodities". NIST may eventually enforce compliance with the Uniform Regulation and other regulations, but does not do so at this time.

Implied warranties. In some states, purchasers of certain products may also be protected by *implied warranties*. If "the seller at the time of contracting has reason to know any particular purpose for which [the] goods are required and that the buyer is relying on the seller's skill or judgment to select or furnish suitable goods," then "unless excluded or modified [by statute], [there is] an implied warranty that the goods shall be fit for such a purpose."[2] In Indiana, this standard has been interpreted by courts to mean that trees sold or offered for sale will be reasonably fit for and adapted to the purpose for which they were sold.

Summary. The legal protections for consumers who purchase hardwood seeds and planting stock amount to little more than an assurance that the trees offered for sale are not infested or diseased, and that they have a reasonable chance to grow. Aside from the previously mentioned guarantees or warranties contractually offered by the seller, purchasers of bare-root, own-rooted, grafted, or containerized trees have little or no legal assurance as to the genetic quality or the performance of what they are buying. Terms such as "elite," "superior," "improved," and "genetically enhanced" should be regarded by consumers as advertisements; they mean whatever the seller wants them to mean. Buyers may rely on the reputation of dealers, but they can only determine if a product will meet their needs if dealers provide background information on the genetically improved stock they sell. If dealers do not offer this information, buyers should ask for it. Example questions for consumers to ask dealers are included in Inset 1. The maxim caveat emptor (quia ignorare non debuit quod jus alienum emit) – let the buyer beware (because he or she should not be ignorant of the property that he or she is buying) – applies to reforestation stock, including certified, patented, or trademarked material.

Inset 1. *Sample questions for consumers to ask sellers of improved hardwood stock*

Example questions for buyers of improved seed or seedlings

1. Is the seed certified?
2. Did the seeds come from a seed orchard and, if so, how were the trees in the orchard tested?
3. Were selections based on progeny tests? How much better did the selections perform than unimproved material? Where were the progeny tests located?
4. Were seeds from select trees in the orchard kept separate from and not mixed with any other seed?

If the answer to any of these questions is "no" or if the seller is not sure of the answers, then the buyer has reason to be cautious. A certified seed source is the only legal guarantee of the genetic identity of seeds (or seedlings grown from them). Seeds that were not from a seed orchard may have been obtained from wild, untested trees. If a mother tree has not been evaluated in a progeny test (an experiment where the growth of seedling families is compared to standard or "check" trees; see Selection and Testing below), then it is unlikely that the offspring will be much better than those of a random tree in the wild. If possible, determine if the selected trees in the seed orchard were tested in an environment similar to the one in which you will be planting; otherwise, the seeds and seedlings from the orchard may not perform well on your site. Mixing seed from select trees with seed from non-select trees is a way of stretching the seed supply, but it dilutes the genetic quality of the seed.

Example questions for buyers of improved grafted trees or own-rooted trees

1. Where was the source tree for the scion wood or own-rooted tree originally selected?
2. How was the source of the propagated tree tested?

Vendors should be able to tell consumers what steps were taken to certify the genetic identity of trees being sold. Clonally propagated trees, whether grafted or on their own roots, were derived from a tree that originally grew in and was adapted to some local environment. Try to determine what that environment was and what evaluation process led to the selection of the clone you are purchasing. Improved grafted or own-rooted trees should have been tested against other clones at several locations over many years, and at least one of the locations should have an environment similar to the one where you will be planting.

Tree Improvement Methods

Because improved hardwood trees will be increasingly available in the future, consumers who understand the techniques used by breeders to improve trees will be in a better position to ask informed questions of retailers, to evaluate what they are buying, and to invest wisely for their particular circumstances. Tree improvement programs consist of cycles of selection, breeding, testing, and commercial deployment (Fig. 3). Trees are initially selected from wild populations. The wild trees or their offspring are tested to determine which of the original selections are best. Improved material can be commercially released from the program at any stage in the cycle. Terms such as "selected," "improved," and "elite" may be used to describe products from various stages of these programs. **There is, however, no universal or standard meaning for these terms among tree improvement programs.**

Is it genetics or the environment? Much of the time and cost of a tree breeding program is devoted to understanding the separate effects of environment and genetics on tree performance. A tree in a forest or plantation that has a superior appearance may or may not have superior genetics, and the genetic quality of a tree cannot be judged by appearance only. Not all traits are genetically controlled to the same degree. Some traits that breeders try to improve, such as growth rate, are under genetic control but are also strongly influenced by environmental factors (site quality, competition, and pests). Other traits, such as resistance to some pests and straightness may be less affected by environmental factors. Selection and breeding are most effective for traits that are more strongly influenced by genetics.

Figure 3. *Flow chart showing cyclic nature of tree improvement; blue=selection, green=breeding, brown=testing, pink=deployment to landowners.*

Selection. Trees are selected at the beginning of a program and then in succeeding generations of the breeding cycle.

Figure 4. *A forester evaluating a forest-grown walnut for selection as a seed source. (Photo courtesy Rod Robichaud)*

Initial selections are made in natural stands or unimproved plantations (Fig. 4). In plantations, where trees of the same species are growing nearby under fairly uniform spacing, trees are sometimes selected based on comparison with surrounding trees. In natural stands, where tree age and growing conditions vary more, a comparison to nearby trees is less effective. Many initial selections are dropped from breeding programs after testing because they are not genetically superior.

Advanced generation selections are based on the testing process, described below. These tests allow more accurate identification of superior trees. The amount of genetic improvement, or genetic gain, made through selection depends on how much a trait is controlled by genetics and the effectiveness of test design.

Testing. Breeders determine the relative genetic quality of selected trees by planting either clones (genetic duplicates) of a selected tree, or seedling offspring, in tests repeated over years and in different locations. The most common type of test is called a progeny test, in which seedlings of a tree are planted and measured to evaluate the mother trees' genetic worth (Fig. 5). Most tests include "check lots" of non-selected material. Comparing the performance of selected trees to these check lots provides a way to measure their superiority relative to unimproved trees. Tests also help determine the adaptability of selections. Selected trees that are genetically superior for growth rate and form in one region may not be superior in another region because they are not well adapted to conditions there. Tests that are repeated in locations covering several climatic zones will indicate how adapted a selected tree is to those zones.

Breeding. Breeding selected trees with one another provides new genetic material for selecting and testing. Selected trees are allowed to mate using natural or open pollination. This means that only the mother of the resulting seed is known. Open pollination is often used because controlled pollination (using bags to isolate flowers and manually applying pollen from a known source) is time consuming and costly. Controlled pollination allows greater potential for improvement than open pollination since both the father and mother are known.

Delivery to consumers. Improved seeds, seedlings, and grafted trees can be released for sale at any point in the breeding program. Breeding programs differ from one another in many important ways, including which trees are initially selected for the program, what combination of traits is selected, how intensively each trait is selected, and how and where testing is performed. This means the performance of trees from similar stages of different programs will not be the same. Different terms are often used by different programs to describe products from the same stage of the breeding cycle.

Types of Commercial Products

Own-rooted trees. Own-rooted trees, sometimes called simply "rooted" trees, are genetic

Figure 5. *A forester has selected the tree right of center and flagged it with a yellow ribbon. The tree's shape was the result of genetics interacting with environment. This selection will be progeny tested to see if the seedlings inherit excellent growth rate and form. (Photo courtesy Brian Beheler)*

clones much like grafted trees, except the above-ground parts of own-rooted trees have their own root system rather than being grafted onto a genetically distinct rootstock (Fig. 6). In other words, with own-rooted trees the roots are genetically identical to the shoots. Own-rooted trees can be produced from cuttings (typically sections of branches or roots) or from tissue culture. Sometimes own-rooted trees are called **stecklings**. Own-rooted trees provide landowners with the greatest control over the *genetics* of their planted trees, but the amount of improvement depends on the genetic quality of the original plant. Rooted cuttings are commercially available for some ornamental tree varieties. Own-rooted trees of some conifers and hardwoods are used for timber and fiber plantations, but they are not yet available for any fine hardwood species.

Grafted trees. Branches (scions) from selected trees are usually grafted onto 1-0 bare-root seedling rootstocks and then sold a year or two later as grafted trees (Fig. 7). Nurseries can produce genetically identical copies of a desirable tree by grafting. Although the shoots of grafted trees may be perfect genetic copies (clones) of the original donor tree, different grafted trees of the same clone can perform differently because of the effect of the rootstock and differences in the environments in which they are planted. Errors in the propagation and labeling of grafted trees can be difficult to detect, so the quality of grafted trees depends on the skill of the grafter and the care taken in growing the graft and maintaining

Figure 7. *Graft union between rootstock (with rough bark) and selected scion. The rootstock and scion are genetically different, but function together as one tree. This grafted tree is three years old. (Photo courtesy Jim McKenna)*

Figure 6. *Own-rooted cuttings of butternut. The small, white roots that have emerged from the stem pieces are genetically identical to the rest of the plant. (Photo courtesy Paula M. Pijut)*

the scion's identity. Because grafts cost more to produce than seedlings, consumers should expect to pay more for grafted trees than improved seeds or seedlings. Purchasers of grafted trees should carefully consider whether the performance of grafts is worth the added expense. As with own-rooted trees, the amount of improvement of grafted stock depends on the genetic superiority of the tree that produced the scion.

Seed from initial selections. Seeds collected from trees in natural stands or plantations are sometimes marketed commercially. These source trees may or may not be genetically superior, and the seed from these trees is typically pollinated by unselected nearby trees, further diluting any qualities of the selected tree. Seed of this type provides consumers with the least amount of genetic control over their planting stock.

Seed from seed orchards. Seed orchards may contain grafted trees or seedlings of selected trees and are used as sources of improved seed (Fig. 8). Seed orchards are often planted before the selected trees in them have been thoroughly tested. As testing progresses, genetically inferior grafts or seedlings are removed, or *rogued*, from the orchard. As roguing progresses, the genetic superiority of the seed from the orchard increases. If the trees in a seed orchard have been tested and proven to be improved mothers, then they will usually function as improved fathers too. This means seed from rogued orchards have up to twice the potential of seeds collected from the same mother trees in natural stands or unimproved plantations. That is the theory. In practice,

Figure 8. *A black walnut seed orchard containing select, grafted trees. This seed orchard provides improved seed to the state of Indiana. (Photo courtesy Jim McKenna)*

the accuracy of the testing procedures, the selection practices used to establish a seed orchard, and the amount of pollination by trees outside the orchard will determine the superiority of seed-orchard seeds.

Hybrid trees. What about hybrid walnuts? Hybrid seed corn has been such a spectacular success that people sometimes mistakenly use the word "hybrid" to mean having superb genetics and performance. Hybrids are crosses between two plants that are genetically different. By this definition, almost every hardwood tree is, technically, a hybrid. The word hybrid is also used by tree breeders in a special sense to mean trees that are the offspring of a cross between *different species* (interspecific hybrids). Tree breeders have discovered that by crossing members of different but closely-related species they can produce offspring that have a mix of characteristics of both species (Fig. 9). Interspecific hybrid seedlings are are extremely variable. Some have exceptional

Figure 9. *Vigorous, three-year-old inter-specific walnut hybrids growing in central Indiana. (Photo courtesy Jim McKenna)*

vigor, making them valuable, but many others have unacceptable form or wood color that reduces their commercial value in spite of their faster growth rate. Hybrid hardwoods are not well tested, and their potential is not yet understood. Landowners who are interested in planting hybrids should determine from dealers if the hybrid trees are from inter- (between) species crosses or intra- (within) species crosses and should ask log buyers if the mature hybrid is likely to find a market.

What to Expect

What can consumers reasonably expect from improved seed and grafted trees? Some of the best improved parent trees for which there are reliable data now produce seedlings that grow as much as 10 percent faster (measured by diameter growth) than average trees on good to excellent sites. On fair or poor sites there were few if any differences between improved and unimproved trees. Many improved walnut trees were not selected because they were fast growing, but because of their superior timber form, and not all breeders judge timber form using the same criteria. The best improved walnut parent trees that were selected for *form* produced trees (grafted) that grew considerably straighter than average. Hammitt (2001) found that grafted trees and seedling trees from a seed orchard had considerably better form (as much as 30 percent), but only a slight improvement, if any, in diameter at breast height (dbh) compared to run-of-the-mill 1-0 nursery stock. Other studies have shown that when selection was focused on diameter growth only, it was possible to realize a gain in dbh of 20 percent or more over unimproved stock. A 10 or 20 percent improvement in growth translates into more volume or earlier harvest, and improvements in form can increase the value of a tree at any merchantable size. Since both volume growth and form are influenced by competition, the way a plantation is managed will greatly affect the performance of improved stock.

Getting the Most from Your Trees

Matching species and site. Planting trees in the proper site is the first step toward getting the most out of genetically improved stock. Some hardwoods only grow well on particular types of soils and in particular climates (Fig. 10). Genetically improved trees will grow best on the best sites for the species. On poorer sites, the differences between improved and unimproved trees may be small.

Management, site, and genetics work Together. Without active management, the money spent on improved trees is wasted. The performance of improved trees will depend to a great extent on their management and the quality of the growing site as described above. Outstanding site quality and management will never yield the maximum return unless trees of the best genetic quality are used, yet good genetics cannot compensate for neglectful management or poor site quality. Every landowner must decide if the

Figure 10. *A poor match of species and site. These 30-year-old black walnut trees will never reach their potential because the soil on this site limits their growth.*

extra cost of improved stock is worth the *potential* return given the site and level of management the plantation will receive. The concept of combining good genetics and good management is accepted in agriculture and in forestry where genetically improved material is available. The relationship between management and genetics is critical to producing quality hardwoods (Fig. 11).

Synopsis

Tree breeders share landowners' optimism by working to make sure that even the "average" trees of this generation are a little better than the average tree available 20 years ago. By understanding the methods and terminology of tree improvement, landowners can make informed decisions about what to expect from advertised products and whether they are a good value.

Figure 11. *A mixed pine and hardwood plantation being managed for hardwood timber production. The landowner and forester have matched the type of planting stock to the landowner's needs and management budget. (Photo courtesy Brian Beheler)*

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Footnotes

[1]The authors are not attorneys, and the content of this publication should not be considered legal advice; it is presented for the convenience and guidance of the reader. For legal advice always consult an attorney licensed to practice in your state.

[2] Indiana Code 26-1-2-315*; Weller v. Bectell,* 2 Ind. App. 228, 232, 28 N.E. 333, 334 (1891).

[3]Most state laws refer to and rely on an "official seed certifying agency," that may or may not be run by the state (can be privately operated), but is authorized under state law and generates standards and procedures approved by the U.S. secretary of agriculture to assure the genetic purity and identity of the seed certified.

Appendix 1. Descriptive summary of state provisions relating to seed certification programs, requirements, and regulations.

Indiana	Burns Ind. Code Ann. §15-4-1-6 (2005) Unlawful to distribute agricultural or vegetable seeds unless tested and labeled in accordance with state law; must meet standard for maximum content of "noxious weed seeds"; cannot be represented as "certified," "registered," or "foundation" seed unless it meets standards for such labeling as set for by "officially recognized seed certification agency."[3] False representation is illegal.
Iowa	Iowa Code §199.1 (2004) Defines "certifying agency" which alone has authority to determine standards for seed certification under state and federal law.
Kansas	K.S.A. §2-1415 (2005) "Noxious weed seeds" are listed by name. Unlawful to sell agricultural seed for planting or seeding purposes that has not been tested or labeled; does not apply to unprocessed seed; buyers and sellers maintain their civil liability in contractual arrangements governing the sale of agricultural seed.
Kentucky	KRS §250.021 (2004) Unlawful to "condition" seeds (treat them in any way that changes the purity or germination of the seed). Exemptions listed in §250.42 were repealed in 2004.
Michigan	MCLS §286.71 (2005) Sets out definitions for certified and other classes of seed; authorizes state director of agriculture to promulgate rules and regulations governing certification of seed; certain persons under certain circumstances exempted from law in 1995. MCLS §286.72 (2005) Designates director of department of agriculture as legal seed certifying officer of the state who can set out rules governing certification of seeds; can authorize advertising and sale of seeds as certified that share "common characteristics within a species" even if they do not meet state's requirements for certification as long as other requirements as met, including a requirement that the director publish a list of such seeds (1959, 1960, amended 1986).
Minnesota	Minn. Stat. §21.80-21.92 (2005); §21.91 (2005) Designates officially recognized seed certification agency; use of "certified" means compliance with agency's definitions for genetic content and purity; official state agency for certification to be determined by commissioner of agriculture and director of Minnesota Agricultural Experiment Station.
Missouri	§266.095 R.S. Mo. (2005) Seed certification may be carried out by agency or association designated by director of Missouri agricultural experiment station at Columbia.
Nebraska	R.R.S. Neb. §81-2, 147.01, 151, 152 (2005) University of Nebraska Institute of Agriculture and Natural Resources may designate agency for seed certification; must operate as not-for-profit.
Ohio	ORC Ann. §§907.01, 907.02 (2005) Restricts use of "certified," "registered," and "foundation" to seeds that have been certified by Ohio seed improvement association, which must adhere to minimum standards established by association of official seed certifying agencies; restrictions apply to advertising and sale of seeds and plants.
Pennsylvania	3 Pa.C.S. §§7102, 7109 (2005) Established certification inspection service and tests through state department of agriculture; certifying agencies must be authorized under state law.
West Virginia	W.Va. Code §19-16-1 (2005) Designates "certifying agency" as one approved by USDA to assure genetic purity and identity of the certified seed.
Wisconsin	Wis. Stat. §94.40 (2005) Establishes Wisconsin Crop Improvement Association as seed certifying agency for all agricultural and vegetable seed in the state (in cooperation with UW-Madison); agency authorized to establish all standards and procedures for certification of seed, subject to approval of state department of agriculture.

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