

STRATEGIC PLANS FOR THE HARDWOOD TREE IMPROVEMENT AND REGENERATION CENTER

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Key Words

Hardwood research, molecular genetics, genetic engineering, seed orchards

The mission of the Hardwood Tree Improvement and Regeneration Center (HTIRC) at Purdue University is to advance the science of hardwood tree improvement and genomics in the central hardwood region of the United States by:

- Developing and disseminating knowledge on improving the genetic quality of hardwood tree species,
- Conserving fine hardwood germplasm,
- Developing elite hardwood trees for restoration and regeneration of sustainable hardwood forests and riparian zones for production of forest products and maintenance of genetically diverse ecosystems, and
- Developing recognized and respected science leaders in hardwood forest genetics.

The HTIRC is a regional collaborative research, development, and technology transfer effort. The partnership includes the USDA Forest Service North-Central Research Station, National Tree Seed Laboratory, and Northeastern Area State and Private Forestry; Purdue University Department of Forestry and Natural Resources; Indiana Department of Natural Resources Division of Forestry; Indiana Hardwood Lumbermen's Association; Walnut Council; and the Fred M. vanEck Trust. The HTIRC is unique in several aspects:

- It has a regional focus on states comprising the central hardwood region,

- It is a true partnership of federal, state, university, industry, landowner groups, and private individuals who contribute financial support and advice, and
- It will generate basic knowledge and applied technologies in hardwood tree genomics, improvement, and regeneration for tree nurseries, industry, agencies, and landowners.

The HTIRC is located at Purdue University because of its role in the Midwest as a recognized center for agricultural genomics research. It is housed in the Whistler Hall of Agricultural Research with biotechnology and genomics faculty and 6 departments in the school of agriculture. This collocation of genetics faculty is intended to stimulate cross-fertilization of research ideas and multidisciplinary research. In addition, because of the high standards of achievement and international recognition of its faculty, high-quality undergraduate and graduate students will be drawn to the various programs represented in Whistler Hall.

The idea for HTIRC was conceived in 1998 because of a perceived void in hardwood tree improvement research in the central hardwood region of the Midwest and Northeast. The birth of HTIRC occurred at the same time that the region was experiencing a severe production shortage of hardwood seedlings, which was estimated to be anywhere from 25 to 50 million trees annually, and production was expected to continue to decrease 20% annually. In addition, the majority of seedlings being produced in state nurseries

were of an unknown genetic source because nurseries rely upon seed collectors to collect and transport seeds to the point of purchase at the nursery. Thus, the majority of seedlings being produced are unimproved, of unknown fitness for sustainable forestry, and of unknown genetic diversity.

The hardwood industry was also concerned about the future quantity and quality of the resource for its lumber and manufacturing sectors. Due to political and social pressures, federal forests have significantly reduced the volume of hardwood timber that is being harvested annually. Small private woodlots that supply a significant amount of hardwood timber are not being managed in a sustainable manner, ownership is not continuous over numerous rotations to ensure sound forest management, and many woodlots are being converted to residential and recreational uses. In addition, the diameter of timber harvested today continues to be smaller than what it has been due to shorter rotations. Last, the hardwood industry was concerned that it was not taking advantage of new biotechnologies that could increase wood production through tree improvement activities that improve wood quality, growth, and pest resistance.

The professional forester community was also concerned about loss of genetic quality in remaining hardwood woodlots and natural forests. They felt that trees that are currently being managed for future timber harvest do not have the same desirable traits for straightness and vigor and that past forest harvest practices of continually taking the "best" trees may have resulted in loss of genetic quality of remaining germplasm. The international economic, social, and political environments also influence the demand for hardwoods. Human population growth continues to expand rapidly, and consumer demand for quality hardwood, at some point, will outstrip the region's ability to produce it unless consumers are willing to accept substitute materials. Much of the United States and European demand for hardwood lumber is currently met within the United State's northern and central hardwood zones, and hardwood production has not shifted to developing countries in any significant manner. The time may come when this pattern of production for world markets can no longer be maintained because of decreased

supply and the environmental consequences of heavy timber extraction on natural environments.

In the central hardwood region, water quality has been degraded by agricultural intrusion along waterways, and flooding has further degraded these riparian zones that include major rivers and their tributaries. A significant effort is being made to restore hardwood trees and other native vegetation in these riparian zones. For the most part, unimproved trees are being used, and knowledge of how to restore these degraded areas is lacking, which has resulted in the failure of many plantings. The opportunity exists for this significant portion of the land base to be a future site for quality hardwood regeneration, although political forces will influence that reality.

Funding for many conservation plantings comes from the Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), and Wetland Reserve Program (WRP). These programs currently account for the majority of hardwood tree planting, and they are increasingly focused on improvement of water quality and wildlife habitat. The genetic characteristics of the trees being planted are unknown, and the potential exists for genetic failures as these plantings reach maturity. Many consumers have not differentiated between the role of plantation forests and natural forests. They readily accept that agronomic crops are grown for the purpose of food production and consumption rather than for regeneration of annual vegetation. However, consumers have similar aesthetic and spiritual values that they hold for trees whether they are in an urban, plantation, or natural forest environment. If this does not change, plantations may not be accepted as the alternative method for growing highly productive crop trees that would allow the country to maintain natural forests as preserves for biodiversity and recreation. These attitudes exist despite the fact that it would take only a marginal set aside of land currently in forestland cover to produce all of the wood necessary to meet human demands for wood consumption.

Central and northern hardwoods are more desirable than southern hardwoods because of slow, more even growth and the supply of European hardwoods is limited. Because of this, the HTIRC will hold unique importance with the Central United States to develop superior

hardwood trees for markets that supply developed nations. There are no other hardwood tree improvement research centers in the world and few individual hardwood research programs that have a mandate to satisfy a regional clientele and are financially supported to undertake a long-term program in tree improvement.

HTIRC will be unique because of Purdue University's relationship with Donald Danforth Plant Science Center in St. Louis, MO. The Danforth Center is a partnership of the Missouri Botanical Garden, Monsanto, Purdue University, University of Missouri-Columbia, University of Illinois, and Washington University in St. Louis. Its mission is to increase understanding of basic plant biology and apply new knowledge to sustain productivity in agriculture and forestry. HTIRC should benefit from its access to world-class plant scientists and its ability to collaborate in the graduate education of its students.

HTIRC will be virtually integrated with molecular and classical genetics, tree physiologists, silviculturists, and nursery and regeneration specialists. Its strength will be its ability to perform basic, applied, and developmental research so the basic genetic knowledge that is created will be delivered to industry and private landowners in value-added products rather than knowledge that only benefits the scientific community.

HTIRC will not be the single or sole institution performing hardwood research desired by the hardwood industry, nursery operators, government agencies, forest landowners, and the general public. The region has many outstanding scientists who perform valuable basic and applied research on various species, and it will be essential that the whole hardwood scientific community remains viable to meet these research needs. In addition, HTIRC itself will not employ pathologists, entomologists, biochemists, enzymologists, economists and all of the other scientific disciplines that will be necessary for research collaborations to provide scientific data for evaluation of the ecological and environmental fitness of HTIRC products. Productive working relationships with scientists from other institutions are necessary for the success of the center.

STRATEGIC DIRECTIONS

HTIRC has 6 strategic directions:

1. Improve the genetic quality and regeneration of fine hardwoods, including black walnut, black cherry, and northern red oak, through application of classical breeding, genomics, molecular markers, genetic modification, advanced propagation, seed production, technologies and silviculture.
2. Establish a highly credible hardwood genetics research center that will be recognized as a leader in forest genetics and thereby become a leading graduate education and training facility for future scientific leaders in hardwood forest genetics.
3. Hire and nurture pre-eminent scientists who will build the credibility of the research program and be highly competitive for federal research grants.
4. Establish the Martell Experimental Forest and Conference Center as a significant site for education and training of consulting foresters, nursery practitioners, and landowners in nursery management and hardwood culture.
5. Communicate, convey, and market the work of HTIRC in order to be perceived as the pre-eminent international center for hardwood genomics and biotechnology.
6. Secure funding for an endowment to ensure long-term organizational stability, provide for operating support of the research program, and establish funded research positions with the center.

OBJECTIVES

The following are objectives for implementing the strategic directions:

- Develop research and technology transfer programs that provide knowledge for management and maintenance of sustainable, genetically diverse natural forests and highly productive domesticated trees for plantation hardwood crops that provide an array of products.
- For black walnut, black cherry, and northern red oak: develop genetic maps, molecular markers, tissue culture and genetic engineering technologies, advanced seed orchard and seed handling technologies, breeding orchards, and

experimental nurseries for the production of elite families and cultivars, identification of superior seed trees, and assessment of genetic quality and diversity in natural stands.

- Assess the need and develop a regional hardwood breeding and seed orchard cooperative for central hardwood seed zones as desired by state tree improvement cooperators.
- Take leadership in documentation of hardwood research discoveries and dispersal of knowledge by hosting scientific conferences, symposia, workshops, and field days and publish books, proceedings, and brochures that convey this knowledge to a wide array of end users.

- Provide for annual evaluation and other periodic review of HTIRC programs to ensure that the mission and vision remain focused and relevant.

ACCOMPLISHMENTS TO DATE

In the initial year since establishment, staff at the HTIRC have developed tissue culture systems for northern red oak and black walnut, developed over 300 black walnut molecular markers for use in genetic mapping and marker-assisted breeding, established new breeding orchards for black cherry and black walnut, and established a field planting for screening Midwest-adapted blight-resistant American chestnut.