



INSTITUTE OF FOREST BIOTECHNOLOGY

Heritage Trees Workshop Meeting Report

North Carolina Biotechnology Center, Research Triangle Park, NC

November 1 – 2, 2001

The American landscape was once defined by tree species that have since been decimated by disease. The American chestnut and elm are the most familiar examples of this rapid and devastating loss of trees important to this country's heritage. As one of its first projects, the Institute of Forest Biotechnology convened a workshop to initiate partnerships and fortify efforts toward restoring Heritage Trees utilizing the American chestnut as a model species.

Representatives from academia, industry, government and private foundations were asked for their insight, perspective and expertise in developing the most appropriate and effective model for the Heritage Trees Program.

OPENING REMARKS

Dr. Dennis Le Master, Professor and Head of the Department of Forestry and Natural Resources, Purdue University

Welcome to the workshop on the Heritage Trees Program of the Institute of Forest Biotechnology (IFB). This is the Institute's first workshop, and it is my privilege to act as its chair. My name is Dennis Le Master, and I am a member of the IFB Board of Directors. I am also professor and head of the Department of Forestry and Natural Resources, Purdue University.

The mission of IFB is to work for societal, ecological, and economic benefits from appropriate uses of biotechnology in forestry worldwide. The purpose of this workshop is directly related. It is to help develop the Heritage Tree Program through a dialogue of scientists, practitioners, and policy makers for regaining or strengthening key threatened tree species indigenous to North American in a way that is scientifically sound, socially acceptable, and environmentally sensitive.

Elaborating, by "developing the Heritage Tree Program" we mean to develop a process for making a framework for:

- Establishing research protocols;
- Conducting risk assessments;

- Finding funding sources;
- Developing project management standards;
- Communicating the results of research.

Your help in this endeavor is solicited. Indeed, we are seeking partnerships necessary for implementation of the Heritage Tree Program, intended to conserve key species from pathogens through appropriate application of the modern tools of molecular biology.

Our first species of interest is the American chestnut, and because of the long-standing and fruitful efforts of the American Chestnut Foundation, we would like to explore collaboration with you in your efforts to preserve this important tree. Furthermore, we would like to explore collaborating with ArborGen in its exciting approach to preserve this species by direct genetic manipulation. Finally, since our tent is big and inclusive, we would like to explore with all of you and the organizations you represent, assembling a comprehensive effort to conserve the American chestnut as well as other threatened species.

I look forward to a very interesting day.

EUROPEAN HERITAGE TREES

*Dr. Kevan Gartland, Professor, Biological Sciences, University of Abertay,
United Kingdom*

Synopsis of presentation:

Heritage trees can be defined in many terms: trees of significance, of historic value, with a story to tell, threatened or symbolic. Examples of these are the Fortingall Yew, the Dunkeld Larch, and the Birnam Oak. The value of heritage trees is significant for preservation, biodiversity conservation, habitat restoration, raising public profile, and providing a signature for forest biotechnology as a collective endeavor that is societally, scientifically and environmentally accepted.

In the United Kingdom, 25 million elms have been lost to disease. There is a war going on in the woods and biotechnology is being utilized to restore this threatened species. Due to environmental and climatic conditions in the United Kingdom, this elm can flower but not set seed. Therefore, many options can be considered for its restoration. Work is being done to modify the internal architecture and three anti-fungal genes are being used to produce GM regenerants. These regenerants will be challenged by the fungus in summer 2002.

THE THREAT OF EXOTIC PATHOGENS TO FOREST TREES

Dr. Robert Bruck, Professor, Plant Pathology, NC State University

Synopsis of presentation:

Disaster results from the combination of an alien pathogen and a native tree or an alien tree and a native pathogen. Many examples of this have been seen in the United

States: chestnut blight, dutch elm disease, sudden oak death, dogwood anthracnose, citrus canker, and white pine blister rust, to name a few. Is containment possible to avoid these ecological disasters? No, due to the limited resources and extensive borders for which APHIS is responsible. Other solutions are to utilize conventional breeding, transgenic plants and genetic manipulation approaches to confer resistance to pathogens. Which methods are best used is a question of goals, values and priorities. Society will decide if there is value in preserving these species. In answering this question, one seriously underestimated impact on forest health and the environment is the extensive use of chemicals to control pathogens.

APPROACHING A SOLUTION

Dr. John Davis, Associate Professor, Forest Biotechnology, University of Florida

Synopsis of presentation:

Two genetic approaches to disease resistance are selection and breeding, and direct gene transfer. In the classical approach, hybrid backcrosses are used. The advantage of this is the assistant role of biotechnology, such as the use of molecular markers to distinguish donor and recipient DNA in relevant regions. Progress using this method is likely to be incremental. The challenges of this approach are the genetic architecture of resistance (1 or 10 genes involved), generation interval is lengthy and synteny or genome compatibility between donor and recipient.

The advantages of direct gene introduction are again the assistant role of biotechnology with the use of recombinant DNA, and the perturbation of the recipient genome is minimal. The challenge is the development of efficient transformation protocols. Microarrays could be used to screen for resistant trees.

THE FUTURE PATH OF BIOTECHNOLOGY IN TREES

Dr. Martin Apple, President & CEO, Council of Scientific Society Presidents

Synopsis of presentation:

At the start of the last century we could not have conceived of such wonders as: synthetic hormones and antibiotics, walking on the moon, cracking the universal genetic code, conceiving a baby in a test tube, cell phones, personal computers, the Internet, transplanting hearts from the dead to the living, producing human insulin in bacteria, and more. They were each revolutions and now we cannot live without them. The dawn of the 21st Century is seeing both important advances and opening a revolution in new opportunities in tree biotechnology.

The current research focus in forest biotechnology is in several areas: increased tree growth rate, reducing losses from disease, inhibiting insect predation, herbicide resistance, sterility, reduced lignin content, enhanced medicinal product production (e.g. Taxol), phytoremediation of soil pollutants, and structural revisions (e.g. altered flowering, changed number of branches per trunk or spacing between branches). In each of these areas, we must ensure that each project is thought through to both understand not only what we can engineer to solve a particular need, but also its short and long term

consequences to ecological health as well as economic potential and social value. Often new alternatives will emerge that better serve and balance all these needs. These assessments are difficult but necessary.

Future needs and directions of forest biotechnology are numerous and include: the need for an ATGC (American Tree Gene Collection) for tree germplasm from disappearing germplasm (tropical hardwoods and all natural disease and pest resistant lines), all plant genes with identified functions, and new transgenic tree genotypes. We need a center for acquiring and sharing technologies among tree researchers. We need a system that ties together all the gene sequence and gene function databases in the world and an online knowledge management process that intelligently stores, retrieves and mines data and discovers and reports to the user new patterns.

Forest biotechnology has enormous potential to solve a myriad of existing problems and provide human benefits. Restoration of ecosystems and ecosystem resiliency and health have nearly unlimited positive potential, and the variety of commercially valuable products is vast. As we proceed, we must be mindful of the wide variety of interacting biological, social and economic systems and how our projects and actions on behalf of forest biotechnology affect them.

CURRENT R & D ON AMERICAN CHESTNUT

Dr. William Powell, Associate Professor, Environmental Science and Forestry, SUNY

Synopsis of presentation:

Today American chestnuts survive in their roots. The SUNY College of Environmental Science and Forestry has been working since 1987 to produce a blight resistant American chestnut. This research has focused on producing transgenes to enhance blight resistance and the development of tissue culture protocols for transformation. *A detailed abstract is attached.*

Dr. Scott Merkle, Professor, Forest Resources, University of Georgia

Synopsis of presentation:

The program at the University of Georgia is focusing on development of an *in vitro* propagation system for American chestnut. This will provide a means of regenerating transgenic American chestnut trees engineered with anti-fungal genes and for mass clonal propagation of promising genotypes generated by the American Chestnut Foundation breeding program. *A detailed abstract is attached.*

Dr. Paul Sisco, Staff Geneticist, The American Chestnut Foundation

Synopsis of presentation:

The American Chestnut Foundation has worked to produce, through its breeding program, a backcross (BC3) that incorporates the resistance genes from Chinese chestnut and is believed to be 94% American in genotype. *A detailed abstract is attached.*

Dr. Charles Michler, USDA Forest Service

Synopsis of presentation:

The Indiana Regional Breeding Program is working to produce 20 lines of backcross 3 (BC3) trees using mother trees currently growing in Indiana and pollen provided by the American Chestnut Foundation Meadowview Farm blight resistant chestnut program. It is hoped that these trees will have traits that make them fit for reestablishment in their native range in southern Indiana. *A detailed abstract is attached.*

AMERICAN CHESTNUT RESTORATION PROJECT

Ms. Dawn Parks, Public and Governmental Affairs Manager, ArborGen

Dr. Lynne Reuber, Team Leader, Mendel Bio

Synopsis of presentation:

A model utilizing multiple methods of gaining disease resistant American chestnut and including multiple stakeholders in the process was presented. In this model, traditional breeding, genomics derived information and gene insertion could be brought to bear on this problem. This could increase the pace and chances of success, demonstrate the value of biotechnology for public benefit, and if successful, produce a blight resistant American chestnut available to the public through a non-profit entity. This model would incorporate stakeholders from industry, academia, foundations, regulatory agencies, NGOs and the Institute of Forest Biotechnology.

CLOSING REMARKS

Dr. Dennis Le Master, Professor and Head of the Department of Forestry and Natural Resources, Purdue University

Several things are evident from the discussion today. First, regardless of what we do, biotechnology is so powerful it will move ahead not only in forestry but in a host of other areas.

Second, IFB and the Heritage Tree Program can play a useful role by carrying out its mission statement, working for societal, ecological, and economic benefits from appropriate uses of biotechnology.

Third, the model tree species should be the American chestnut plus one or possibly two other tree species. In addition, several of you have observed today that multiple strategies are wise, for there are no “silver bullets.”

I would like to quote some of you in my concluding remarks, reading from my notes, things you said that struck a resonant chord.

Bob Friedman: “An important IFB role is to learn what we can about the appropriate use of biotechnology in forestry, when to and how to use the technology.”

John Davis: “The power of genomics and biotechnology is as much being able to describe what is going on genetically as much as manipulating genes.”

Martin Apple: “It would be very helpful to develop at the outset a decision-making matrix of questions with regard to a model species that ultimately need to be answered, and then develop a research strategy for systematically answering them.

Kevan Gartland: “If you use the American chestnut, you have the ability to carry the semi-skeptical public with you.”

Ron Sederoff: “Don’t underestimate the size and scope of the problem. Work it a larger scale.” (Nevertheless) “It is doable; it is time; it is scientifically interesting enough to bring in smart people to work on it.”

ArborGen and Mendel Biotechnology provided us with a very interesting proposal that a Limited Liability Company (LLC) be formed to which technology licenses could be granted for the purpose of producing a blight resistant American chestnut. The LLC would write grants, take the lead in public relations, create and manage the project. It would not do the research, but contract with others to do so.

The idea has merit, and we thank them for offering it, but time does not allow its full consideration. You who are interested in pursuing it are urged to self-select, indicating your interest to Dawn Parks, Lynne Reuber, or Susan McCord. IFB would be very willing to facilitate consideration of the ArborGen-Mendel proposal.

We have had a great day. It is impressive a group of this size would spend an entire day discussing science and the preservation of a tree species. Thank you for the effort.