August 1, 2003

The following are responses from some USDA Forest Service (FS) scientists regarding questions posed for public comment by the "Genetically Engineered Forest and Fruit Trees: Public Meeting" held July 8-9, 2003. The comments are reformatted, slightly edited, and, due to time constraints, have not been reviewed by top FS administration. They do not represent an official FS position on this topic, but are submitted to present the thoughts of some of the agency's key natural resource scientists.

Jay Kitzmiller comments:

- I can easily imagine genes conveying resistance to white pine blister rust being identified and introduced into sugar pine and other white pines species in the future, either through traditional methods or genetic engineering /biotechnology. If these were native genes, there would be less concern (more likely co-evolution has occurred naturally over many generations and epistatic and pleiotrophic effects now favor species adaptation and ecosystem stability) than if the resistant genes originated in a different species.

- The long time period of juvenility in sugar pine and the long life-span would make research studies very expensive and lengthy. Research coordination involving a combination of short-term, highly controlled studies with long-term, field studies would be essential for full evaluation. In addition, consideration would be given to gene expression throughout the life stages including the sexual process.

- In addition to the stressors mentioned in the report, wild and prescribed fire adaptation along with climate change responses would be very important to assess in western forests.

Jay H. Kitzmiller Ph.D.
Regional Geneticist
USDA Forest Service
2741 Cramer Lane
Chico, CA 95928
(530) 879-6607

Dana Nelson comments:

- Regarding overarching question number 1: Are there recommended methods to evaluate gene flow issues? What are those methods? Are there particular genes that would be more suitable than others for this work? I think monitoring genes that are known to be candidates for transgene development would be most direct and important. One class of these includes candidate genes found in natural populations using association genetics. Allele specific markers could be found in these genes and used to estimate gene flow and other parameters of interest.

- Regarding question number2: Would the use of plant or seed sterility systems be useful in some cases? Which cases would those be? Are there other strategies that would also be useful to address gene flow issues? Yes, when pollen and seeds will be produced under the planned production system and the transgenes are known/suspected to increase fitness in the adjacent non-production environments. Using a production system that removes the trees prior to pollen and seed formation would be another strategy.

- Regarding question number 3: Assuming that genes without increased fitness characteristics may persist in the environment, should APHIS evaluate the impacts of this and if so, how should this be accomplished? I suppose they should. For example a gene to change wood properties may be great for trees grown for end-use A, but not for an adjacent grower who is managing for end-use B. One could possibly estimate the impacts that transgene(s) have on the major end-uses of the various product(s).

- Regarding question number 4: Other than the following: outcrossing frequency, compatible species, known hybrids, weedy or invasive nature of compatible species, are there other parameters related to outcrossing that should be evaluated? Frequency of natural hybrids and affect the transgene has on pollen and ovule development and compatibility. Some hybrids that can be made under controlled conditions are very rare in nature. The isolating mechanism can be as little as differing times of pollen and ovule development. Transgene(s) that inadvertently affect this process may cause an increase in hybridization in uncontrolled conditions.

C. Dana Nelson, PhD
Research Geneticist / Acting Project Leader
Southern Institute of Forest Genetics
23332 MS Highway 67
Saucier, MS 39574 USA
228.832.2747.209
dananelson@fs.fed.us

Paul Zambino comments:

- I agree with the assessment that fiber demand will increase. The harvest byproduct that would result from a forest management policy committing to science-based, active and effective management of public and private forests for sustained ecosystem health (i.e., not a production basis) could partially reduce this shortfall in supply. However, hybrid or transgenic tree species may provide an important avenue for ameliorating the problem, and may also be a way of increasing carbon sequestration.

- Use of GE would not come without costs and potential problems, all of which must be carefully considered. Simply stated, forest species and ecosystems have evolved in the way that they have, in order to persist in their habitat with whatever pests and pathogens and long-term environmental fluctuations and stresses might occur. They retain an adaptability or plasticity that has not been replicated in GE monocultures. Altering tree genetics for increased production requires a concomitant change in photosynthate allocation and responses to stress, and so requires a regulated environment, and usually, a shift to intensive management, with whatever effects it carries on soil, water, local wildlife, etc.

- A major question is the settings where such management should be allowed to occur. This could potentially range from low value agricultural land, to prime agricultural land, to river bottom land with high nitrate accumulation in need of remediation, to settings currently occupied by native forest, and from irrigated to non-irrigated situations.

- A number of concerns with GE trees were listed at the APHIS web site:http://www.aphis.usda.gov/ppq/biotech/tree_mtg_agenda.html. Additional concerns could be added, to be checked for each GE situation under review:

    a) As a pathologist my primary concern is: Will monocultures (single species, single or narrow genotype representation) be more susceptible to certain insects or pathogens (or their strains) that are either already indigenous or have not yet been introduced? Could epidemics developing in such monocultures bring about accelerated spread and greater severity in surrounding natural forests, for which intensive remedial management is not practical? How much testing would be adequate to quiet this concern?

    b) Does upregulation of potentially toxic secondary defense compounds occur under previously non-triggering stress conditions and plant tissue locations, and do such compounds leach or volatilize into the environment?

    c) Besides effects on mycorrhizae (mentioned in the APHIS list), does growth and decomposition of the GE trees, (their leaves, fine branches, and roots) alter the soil microbial complement in a way that alters relative ability of affected soil to support normal ecosystem function if GE production is abandoned?

    d) Does the GE species have altered ability to act as allergen (pollen, skin contact with plant or product) to human workers or to animal species?

    e) Much was made of gene flow through dispersal of viable seed and pollen in the list of concerns. A corollary question is, could high production of pollen from GE trees interfere with normal pollenation and seed production of surrounding trees with wild type pollen, even if the GE pollen is nonviable or has diminished viability? How large of a buffer should be left between GE trees and their native counterparts?

f) Will monocultures of genetically engineered trees be allowed to replace stands of natural forests, resulting in loss of native ecosystems, or only be used in conversion of good to marginal agricultural soil? Can or should GE trees ever be used as a replacement for native trees in more natural settings (e.g., for bioremediation of river bottoms)?

g) Will water demands in intensive production of GE trees impact water tables, and cause depletion or water stress to nearby non-managed forests, farms, etc?

h) If GE stands and natural environments are allowed to be in near proximity, will GE monocultures attract animal or bird life away from natural forests, yet be unable to support their survival and reproduction?

To summarize, I am not inherently against use of GE trees. Nonetheless, I have many concerns, and am of the opinion that there are many questions that need to be answered for each GE release. Thus, I feel that both the approval of specific GE crops and establishment of GE plantations should continue to be carefully regulated.

Paul Zambino, Ph.D.
Research Plant Pathologist
USDA-FS Rocky Mountain Research Station
1221 Main St.
Moscow, Idaho 83843
(208)883-2334 FAX(208)883-2318
pzambino@fs.fed.us

Floyd Bridgewater comment:

- There is no doubt that benefits would accrue from the successful implementation of genetic transformation. However, there is a difference between implementation on public versus private lands. There is a good chance, in my opinion, that private industries may be permitted to plant GM trees on their lands. There is almost no chance (again, in my opinion) that GM trees will be planted on public lands any time in the near future. The public probably won't stand for it even if it is demonstrated to be efficacious. There is a good model in Canada. Both British Columbia and Alberta have moratoria on planting GM trees on crown lands. This in spite of the fact that they don't have the technology in place to do it on a broad scale yet. The best chance of seeing GM trees on public lands is to deploy American chestnuts resistant to chestnut blight and to deploy Fraser fir (a G2 species on the global scale) transformed with genes for resistance to Balsam Wooly Aphid from another fir species. Of course, all of the things that could accrue from genetic modification can be had by traditional breeding; it just takes longer. There are other examples, but I don't think the USFS should be supporting the view that GM trees will be deployed on public lands for commercial purposes.

Floyd Bridgwater
Research Geneticist and Project Leader
Southern Institute of Forest Genetics
fbridgwater@fs.fed.us
919-549-4019

Andrew Groover comments:

- Transgenic trees function as important research tools, and help us identify and characterize genes regulating traits influencing forest health and productivity. The results from such research can lead to important applications, but these applications are not limited to deploying transgenics in the wild! For example, knowing the genetic basis of resistance to introduced diseases can guide traditional breeding programs. I think APHIS should make considerations for basic research vs. industrial forestry release of transgenics when they draw their guidelines.

- The guidelines need to be flexible and anticipate new technology. For example, current concerns expressed by anti GMO activists include that genes are introduced at random into genomes, and integration at different loci can influence transgene expression and cause mutations. In addition, selectable markers are used to confer herbicide or antibiotic resistance to facilitate selection of transformed plants. It is likely that these concerns will go away once efficient gene replacement is extended to plants, which is likely to be realized in the next 5-10 years. What will APHIS consider transgenic at that point? For example, would a tree containing favorable alleles from the same tree species that were introduced by gene replacement be considered transgenic if the plant only contained short stretches of non-plant DNA that did not encode for protein?

- Applications should be encouraged that will introduce transgenic technology to the public in a responsible, positive way. The introduction of GMOs in agriculture through technologies seen by the public as being money makers for industry but having no value to the public has caused major roadblocks to using this technology.

Andrew Groover
Geneticist and Project Leader

agroover@fs.fed.us
(530) 758-1060
USDA Forest Service, PSW
Institute of Forest Genetics
Davis, CA