Are genetically modified trees a threat to forests?

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On the subject of genetically modified trees, reliable information is needed to distinguish facts from emotions.

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Genetically modified organisms (GMOs) are organisms that have been transformed by the insertion of one or more isolated genes. Often, but not always, the transferred genes have been derived from a species different from the recipient.

The issue of genetic modification has been subject to passionate debates and has recently revived broader concerns over the introduction of new genotypes (Cock, 2003). Scientists and the public have expressed worries with regard to the risks of potential gene flow (gene transfer to breeding populations or wild relatives, potentially leading to hybridization or introgression, sometimes referred to as genetic pollution) and environmental impacts (including the displacement of local species). Both genetic pollution and displacement of native species also occur with conventionally bred varieties and wild exotic species; but there is uncertainty about the effects of releasing organisms that were obtained by breaking natural barriers that have prevailed in conventional breeding to date. Other concerns include consumer health and potential inequality of costs and benefits to developing countries and poor farmers.

In agriculture, genetically modified organisms (GMOs) are already a reality: the area of genetically modified crops increased from 2.8 to 67.7 million hectares between 1996 and 2003, and genetically modified crops were being raised commercially in 18 countries in 2003 (James, 2003). More than half the area of soybean planted globally is transgenic. Ten genetically modified crops are available in the market, but four crops and two traits account for 99 percent of the genetically modified crops currently being grown. Issues related to genetic modification in the field of food and agriculture are discussed in depth in the 2003-2004 edition of *The State of Food and Agriculture* (FAO, 2004).

The forestry sector is far behind agricultural crops in this respect – and can perhaps benefit from experience in the agricultural sector.

WHAT ROLE FOR GENETIC MODIFICATION IN FORESTRY?

It is not yet possible to reach conclusions about the potential impacts of forest GMOs because of the paucity of reliable information. FAO is currently carrying out the first global review of biotechnology in forestry, including statistics on developments and applications of GMO technology to forest trees (FAO, in preparation). Preliminary results from the study suggest that as of 2002, less than 500 ha of genetically modified forest trees (poplar clones) were being grown commercially, in one country (China). *Populus* is the genus of forest tree in which genetic modification has been researched most widely, although some genetic modification research has been reported for about 19 genera of forest trees.

Almost two-thirds of all research activities on genetic modification in

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Populus *is the genus of forest tree in which genetic modification has been researched most widely (genetically modified* Populus nigra *stand near Beijing, China)*

forest trees are in the United States, with most of the remainder in a few other developed countries. However, the technology is rapidly being developed and adopted in some technologically advanced developing countries.

If genetically modified forest trees are used commercially, the use of materials with controlled reproduction (sterile or with reduced pollen) should be a prerequisite. The traits most likely to be targeted for improvement are insect resistance and wood quality (changes in the composition and amount of lignin) for use in commercial plantation forestry. The aim would be to reduce inputs and increase yields to meet increasing demand for wood, pulp and paper – based on the agricultural model and primarily driven by the private sector. Most first-generation traits under study (e.g. pest resistance, herbicide tolerance), with the exception of wood quality traits, derive from research in agricultural crops; these are traits of interest mainly to the producer, less so to the consumer. However, it is debatable whether the use of genetically modified forest trees for commercial wood production is economically worth the investment at present.

Other uses might be in specific niches; for example, enhancement of specific traits could find applications in ensuring survival of endangered species threatened by pests or diseases, in soil restoration and in urban and amenity forestry, agroforestry and trees outside forests.

A third application of genetic modification technology, often overlooked but arguably the most important, would be in research on tree biology, i.e. studies on gene functioning and the characters genes control.

In many countries the private sector is undecided and reluctant to communicate about its intentions regarding genetic modification in forestry. While companies may fear that failing to engage in GMO research could mean lost opportunities, they generally recognize the power of public opinion and are aware that public resistance to genetically modified forest trees is a commercial risk.

NEED FOR A REGULATORY FRAMEWORK

A regulatory framework to govern research and applications of genetically modified forest trees is essential. The issue goes beyond the country level, since pollen flow and seed dispersal do not consider national boundaries, and since wood is a global commodity. National and international regulatory systems should contain provisions for preliminary risk assessments, monitoring and control and for liability and redress.

Many countries currently have regulations for agricultural crops, including fruit-trees, although many developing countries lack such frameworks and the capacity to implement them. There are no regulations, however, specific to the use of genetic modification in forestry. Although policies and regulations adopted for agricultural crops are also likely to be used for forest trees, forest trees present special challenges (long time frames and life spans, wild resource, major constituents of an ecosystem). Forests are not only trees, and forest ecosystems are more fragile, longer-lived and less closely controlled than crop fields. Decision-making is complicated by the fact that while agriculture is primarily viewed as a production system, forests are generally viewed as a natural system, important not only for the conservation of biodiversity but also for social and cultural values; thus the use of genetically modified forest trees is viewed more as a political and environmental issue than as a technical or trade issue.

At the international level, a few instruments have directly or indirectly addressed exchange and trade of genetically modified forest trees.

- The Cartagena Protocol of the Convention on Biological Diversity (CBD) addresses transboundary movement of living modified organisms (LMOs), including tree seeds and products.
- The International Plant Protection Convention (IPPC) requires that phytosanitary measures for the transboundary movement of plants and plant products (which include trees, although the IPPC does not deal with trees specifically) be based on risk analysis if there is no agreed international standard. LMOs are considered within the IPPC framework only if they are determined to be potential pests (defined as any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products, which includes weeds).
- European Union (EU) Council Directive 1999/105/EC, which addresses marketing of forest reproductive material, requires EU member countries to label all genetically modified material.
- The inclusion of genetically modified material in the Organisation for Economic Co-operation and Development (OECD) Scheme for the Control of Forest Reproductive Material Moving in International Trade has been under negotiation for many years.

Genetically modified trees are also considered in some "soft" (non legally binding) instruments. For example:

- the Forest Stewardship Council has taken a decision not to certify plantations using genetically modified trees;
- the ninth Conference of the Parties to the United Nations Framework

Convention on Climate Change in December 2003 stated that the use of genetically modified trees in carbon sinks is an issue of national regulation.

FROM THE GREEN REVOLUTION TO THE GENE REVOLUTION: WHAT CAN FORESTRY LEARN FROM AGRICULTURE?

In agriculture, the Green Revolution of the 1960s, based on plant breeding and hybrid crop varieties, was promoted primarily by public sector research in both developed and developing countries. The Gene Revolution, in contrast, is being promoted primarily by the private multinational sector in industrialized countries, although it is beginning to gain wider acceptance in developing countries. However, it took the Gene Revolution 23 years to move from the laboratory to the field. At the beginning most of the research was public; the private sector only stepped in when there were elements for a positive return on investment.

The monetary value of forest products in global trade is far less than that of agricultural products, and the economic rationale for employing GMOs in forestry has not yet been clearly demonstrated. Many of the world's forest plantations grow in countries where improved genetic material and appropriate silvicultural procedures are not applied. The success of tree improvement programmes over the past 50 years suggests that there is still scope for enhancing productivity and yields on a sustainable basis through conventional forest tree breeding before resorting to the use of genetically modified forest trees. This is the situation at present, however, and should not be taken to imply that genetic modification technology will not be beneficial when applied to forest trees.

CONCLUSIONS

- GMO technology is still a relatively new tool in forestry; as a tool, it has potential benefits and drawbacks but is not intrinsically good or bad. It can be argued that since it is technically possible, it may be used, and thus its use should be studied and regulated on a case-by-case basis.
- Genetic modification in forestry is much more than a technical issue; sociocultural values and the multiple uses of forests need to be taken into account and public acceptance is necessary if genetically modified forest trees are to be deployed.
- Regulatory frameworks for testing, monitoring and management of GMOs are essential.
- The forestry sector needs to monitor developments regarding GMOs in agriculture. Regulations adopted in crops are also likely to be used for forest trees, but may need adaptation.
- The economic rationale for investing in genetically modified forest trees for commercial application is not directly apparent at present.
- Reliable, tested and agreed protocols for evaluating risks associated with genetically modified forest trees are necessary, but risk assessment in such long-term crops poses challenges. Developing, testing and approving genetically modified forest trees for wider use may therefore entail high costs and long time frames.
- Basic research on forest tree biology could be the most important application of GMO technology.
- Developing countries will need to develop their scientific capacity and expertise so that they can make independent, informed choices and participate fully in the international dialogue on GMOs.
- FAO intends to continue monitoring genetic modification technology and products in forestry at the global level and ensure availability of objective and reliable information.

Genetic modification and other biotechnologies may have a role to play in plantation forestry in some countries. However, since some 95 percent of the world's forest area is natural or semi-natural, the area planted with genetically modified forest trees is likely to remain relatively small. GMO deployment in forestry, if it occurs, is likely to remain in the domain of the private sector and to follow the agricultural model. ◆

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