GMO PBL #3: Transgenic Trees and the BC Forestry Industry

Problem

Canada is the world's largest forest-product exporter. This sector provides the Canadian economy with over 37 billion dollars annually. The importance of this economic sector for Canada has prompted considerable forest management research including potential use of biotechnology to increase productivity. Given their environmental and economic impacts, are transgenic trees a viable way for Canada to protect and improve its forestry industry?

Background

About two-thirds of British Columbia's 95 million hectares is forested. Climate diversity in the region includes a variety of ecosystems including grasslands, temperate rainforests, dry pine forests, boreal black spruce muskegs and much more. The provincial government owns and manages approximately 95% of the region's forests reserving over half for non-timber uses such as conservation and recreation. Throughout the 20th century, the logging industry grew substantially. Although the province developed a Forest Act as early as 1912, logging regulations remained lax until the 1980's when many regional communities voiced their concern over the depletion of the province's forests. As a result, logging companies are now required to present a detailed *Forest Stewardship Plan* which details how the companies plan to uphold the government's objectives such as the preservation of the integrity of the environment and the sustainable commercial use of forests. The last revision of the code was approved in 2004 and called for an increase in corporate accountability. Today, the forest sector remains an important industry for the province, accounting for 7% of employment and 15% of all economic activity.

Nonetheless, the 2006 report on the State of B.C.'s forests shows that the dynamics of the forest ecosystem have deteriorated considerably due to pressures such as forest fires, insect infestations, logging, invasive plant and animal species as well as the effects of climate change. The recent pine beetle outbreak in the pine forest of British Columbia reminds us of the vulnerability of these ecosystems. In 2006, the B.C. Ministry of Forest and Range estimated that 9.2 million hectares of the province's forests were attack by the red pest and forecasted that 80% of the province's mature pines will be dead within the next 5 years.[1]

Given the world's high consumption of timber and pulp products, new forest practices such as high-yield timber crops (where forests are being planted and intensively managed) are necessary to meet the growing world demand. Today, managed forests account for more than a third of worldwide timber income. Tree genomics has the potential to considerably improve the planting stock by reproducing desirable traits such as resistance to insects, extreme climates and herbicide or increasing the wood quantity and quality. Proponents of transgenic trees point out that desired modification to

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[1] Ministry of Forest and Range (2006). *The State of British Columbia's Forests 2006*. Retrieved August 23, 2007 from http://www.for.gov.bc.ca/hfp/sof/2006/pdf/sof.pdf

characteristics could considerably increase productivity. For instance, altering the lignin content or limb thickness could reduce the processing costs whereas pest resistance would limit the number of trees lost to insect infestations. Increases in productivity in turn increase the industry's reliance on timber "crops" thereby shifting timber harvest away from old-growth forests.[2]

Despite the apparent benefits of using biotechnology in forestry, there are many concerns over the social and environmental risks associated with transgenic trees. Unlike GM foods, the health issues associated with genetically modified trees are minimal, given that we do not ingest wood products. Nevertheless, there are concerns over the potential for gene flow and superweed propagation. The concern with gene flow is even more important in forestry than in agriculture because of the longevity of the trees and the higher likelihood that similar species will be growing close to GM trees. Gene flow could create considerable species displacement and ecosystem disruption. For instance, if Bt (the famous pest resistant gene transferred to plants) were applied to trees it could escape to select wild trees, which would gain competitive advantage over other species, disrupting the balance of the natural system. In China, the planting of a million pest resistant transgenic trees to slow desertification resulted in significant out-crossing with wild local species. However, the consequences of the gene transfers are not yet clear.[3]

Example

In 2001, Genome BC and its partners initiated the *Treenomix* research project which aims to help the British Columbia government manage its forests resources in a sustainable manner, help forests withstand new environmental threats and improve the quality of wood produce in the province. This research focuses on important tree species in the Canadian forestry industry (spruce and the poplar) in an attempt to determine which markers correlate with desirable traits such as fast growth, pest resistance, adaptation to the environment, longevity and wood quality. It is hoped that the thorough knowledge of tree biology will help improve the accuracy of breeding programs for spruce, poplars and other pine trees.[4] In 2006, the research group successfully completed the world's first physical map and sequencing of a tree genome.[5] Alongside the *Treenomix* project, is GE^3LS Activity, which engages Canadian stakeholders and the wider public in discussions and debates over the issues surrounding tree genomics in hopes of establishing a consensus and developing recommendations for the federal and

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[2] Sedjo, Roger. A (April 2004). *Transgenic Trees: Implementation and Outcomes of the Plant Protection Act*. Retrieved August 23, 2007 from http://www.rff.org/rff/Documents/RFF-DP-04-10.pdf

[3] Lisa McDonnell (Winter 2007). "Can You See the Forest for the Transgenic Trees", *Science Creative Quaterly*. Retrieved August 24, 2007 from http://www.scq.ubc.ca/can-you-see-the-forest-for-the-transgenic-trees/

[4] Genome BC (2007). *Treenomix: Mechanisms of Wood Formation and Pest Resistance in Forest Trees Using Spruce, Poplar and Arabidopsis.* Retrieved August 23, 2007 from http://www.genomebc.ca/research_tech/research_projects/forestry/treenomix.htm

[5] UBC Public Affairs (September 2006). *UBC Research Major Contributor to World 's First Tree Genome*. Retrieved August 23, 2007 from http://www.publicaffairs.ubc.ca/media/releases/2006/mr-06-094.html

provincial governments.[6] In order to create an informed and constructive dialogue, GE^3LS project leaders are proposing different forest management scenarios that may or may not rely on transgenic trees and attempt to evaluate the effectiveness of each alternative in addressing problems such as climate change, insect damage, timber supplies, and socio-economic impact on communities.[7] In 2006, as an offspring of the *Treenomix* project, Genome BC and its partners began the *Conifer Forest Health Genomics* project, which looks specifically at spruce's resistance to the spruce weevil pest.[8]

In the United States, the Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) is in charge of determining whether genetically modified organisms, including trees, are safe to be used commercially. In order to get "deregulated", the developers need to perform field-testing and report their result to APHIS and any other important information or experience. Upon receipt of these document, APHIS will hold a committee meeting determining the fait of the genetically modified product. In general terms, APHIS requires that the "organism must not directly or indirectly cause disease or damage to plant, plant parts or processed products of plants and that the risks are not greater than those for traditional plants". If APHIS concludes that the GM product is safe than it can be transported, released and exchanged in the country. As of 2004, the APHIS agency had deregulated over 59 deregulations only one of which is a transgenic tree: the Papaya. In the forties, the Papaya tree was severely attacked by an insect-borne virus, the papaya ring spot virus (PRSV). Despite shifting the production from Oahu to Hawaii, the virus still affected the tree prompting researchers to insert a viral-coated protein, developed from other plants into the papaya. The results were outstanding; a 1994 field survey showed that control plants were infected within 11 months whereas transgenic plants remained healthy even after 35 months[9].

Many biologists oppose the United States deregulation process, arguing that it should take into account the plant and its attributes rather than simply the fact that it went through a genetic modification. Therefore, the deregulation process would apply to all plants whether they were the result of traditional breeding or genetic engineering. Only Canada regulates on the basis of this "novelty" standard. Europe, although it does not use the "novelty" standard, is perceived as the most stringent deregulation process in which it is required that GM plants present no additional or increased risks.

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[6] Genome BC (2007). *GE^3LS Integrated Projects*. Retrieved August 23, 2007 from http://www.genomebc.ca/ethics/research/activities/conifer_forest.htm

[7] Treenomix (2007). *GE^3LS*. Retrieved August 23, 2007 from http://treenomix.ca/Home/ResearchActivities/GE3LS.aspx

[8] Genome BC (2007). *Conifer Forest Health Genomics*. Retrieved August 23, 2007 from http://www.genomebc.ca/research_tech/research_projects/forestry/conifer_forest.htm

[9] Sedjo, Roger. A (April 2004). *Transgenic Trees: Implementation and Outcomes of the Plant Protection Act*. Retrieved August 23, 2007 from http://www.rff.org/rff/Documents/RFF-DP-04-10.pdf

Guiding questions

- What are the benefits of genetically engineering trees?
- What are the dangers associated with transgenic trees? Is evidence conclusive?
- What foreseeable impacts could transgenic trees have on the different stakeholders? Will it improve or worsen their condition?
- What are the regulations in place for commercialization of transgenic trees in Canada? How do they compare to those of the United States or Europe?
- What are the concerns over the Canadian regulatory systems? How can they be improved?
- What is the role of the government in encouraging biotechnology research on transgenic trees?
- How can the concerns of the stakeholders be heard and answered? Is it important to hold public consultations?

Resources

1. Canadian Forest Services - http://cfs.nrcan.gc.ca/sector
2. Canadian Biotechnology Advisory Committee - http://cbac-cccb.ca/epic/site/cbac-cccb.nsf/en/Home
3. Government of Canada: BioPortal - http://www.bioportal.gc.ca/ENGLISH/BioPortalHome.asp?x=1
4. Genome BC – http://www.genomebc.ca
5. Genome Canada - http://www.genomecanada.ca/

Community engagement

1. UBC Centre for Plant Research - http://www.ubcbotanicalgarden.org/research/
2. Michael Smith Laboratories - http://www.michaelsmith.ubc.ca/
3. UBC Faculty of Agricultural Science – http://www.agsci.ubc.ca/research
4. UBC Department of Forestry - http://www.genetics.forestry.ubc.ca
5. Genome BC - http://www.genomebc.ca