

## IMACFORD

### Use of improved or genetically modified trees Potential threat to forest health and biodiversity



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## Introduction

### • Advantages of improving trees:

- reduction of pest damage
  - reduction of insecticide application
  - quicker response to invasive species
  - decrease pressure for timber on natural forests
- Forest health | biodiversity

### • Ecological risks associated with improved or GM trees

- ethical and technical problems
- main impediments to the use of improved tree varieties.

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## FOREST HEALTH

### 1. Evolution of resistant biotypes in pest insects

#### Mechanisms

- natural selection process operates in an accelerated and directed fashion
- high selection pressure due to
  - lower tree diversity
  - narrow genetic resistance traits
  - long-term transgene expression
  - uniform transgene expression

#### Effects

- loss of tree resistance efficiency
- resistant biotype potentially more damaging
- cross resistance to other pesticides or natural plant defence chemicals
- resistant biotypes in polyphagous pest damaging other crops
- reduction of the efficacy of environmentally friendly insecticide like Bt

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## FOREST HEALTH

### 2. Adverse effects on natural enemies

#### Mechanisms

- Cascade of magnified adverse effects in the upper levels of the food-web
  - fewer preys and host
  - higher cost of host finding and handling
  - lower reproductive capacities

#### Effects

- collapse of natural enemies populations
- lower biocontrol efficiency
- emergence of secondary pests

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## FOREST HEALTH

### 3. Side effects on herbivorous species

#### Mechanisms

- Secondary pests released from competition with target pest species
- Secondary pests evolve more quickly resistance
- Unexpected effect of transgene insertion in the host tree genome increase tree susceptibility to other pest insects
- Breeding for unrelated plant properties (vigour, wood quality...) increase tree susceptibility or palatability to other pest insects
- Lower genetic diversity in (clonal) plantation reduces adaptability, e.g. direct pest resistance or effect of climatic change on tree resistance
- Diversion processes

#### Effects

- Increase damage from primary pest preferring GM or improved trees
- Outbreaks of secondary pests
- Increase damage on other tree species or unimproved nearby plantations

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## FOREST BIODIVERSITY

### 1. Off-site effects: - dissemination of GM trees - transgene transfer

#### Mechanisms

- Spreading of modified pollen & cross hybridation
- Gene transfer to unrelated species via bacterial vectors
- Movement of propagules, vegetative reproduction, escape of transgenic trees adapted to a wider range of site or climatic conditions, with faster growth...
- Generalisation of improved varieties (highly productive, best quality)

#### Effects

- Introgression with related species
  - modification of plant diversity's quality
- Weeding behaviour of GM trees (invasive organisms)
  - threat to qualitative and quantitative plant biodiversity
- Simplification of plant diversity
  - loss in associated flora and fauna, via food web interactions
- Simplification of crop diversity
  - change in land use and associated diversity

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## FOREST BIODIVERSITY

### 2. Local effects: ➤ improved traits

- Insect resistance
  - ➔ reduction in herbivorous diversity
  - ➔ cascading effects on associated fauna via food-web interactions
- Tolerance to adverse soils (dry, acidic, saline)
  - ➔ competition with native flora
- Fungi and virus resistance
  - ➔ toxic effects on decomposer and soil biodiversity
- Quality traits (lignin / cellulose)
  - ➔ effect on palatability to xylophagous animals
- Growth traits
  - ➔ enhance tree competitiveness with native flora
  - ➔ greater water and nutrient demand w. decline of site productivity
- Sterility traits
  - ➔ loss of species feeding on flowers (nectar, pollen), seeds, fruits

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## FOREST BIODIVERSITY

### 2. Local effects: ➤ plantation management

- Intensive use of herbicide associated with GM herbicide tolerance
  - ➔ destruction of native woodland flora and depending fauna
- Reduced tree diversity, monotonous structure of plantation
  - ➔ lower species richness
- Shorter rotation
  - ➔ change in plant succession

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## Conclusions

- Effects of both products (improved or modified traits) and processes (transgene insertion and plantations practices)
- Long list of ecological risks associated with the use of genetically improved or modified trees
- Risk: potential rather than observed problems  
few documented ecological impacts in forest  
due to moratorium or secret application

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## How to evaluate the ecological risks ?

### 1. To experiment:

- Genetic diversity and global biodiversity
- Ecological research in complex and long-term interactions between GM (improved) trees and food-web related species

### 2. To develop Risk Assessment

- GM crops in agriculture
- Pesticide application
- Traditional tree breeding
- Introduction of beneficial organisms
- Invasion by alien species
- Conservation of genetic diversity and conservation biology<sup>10</sup>