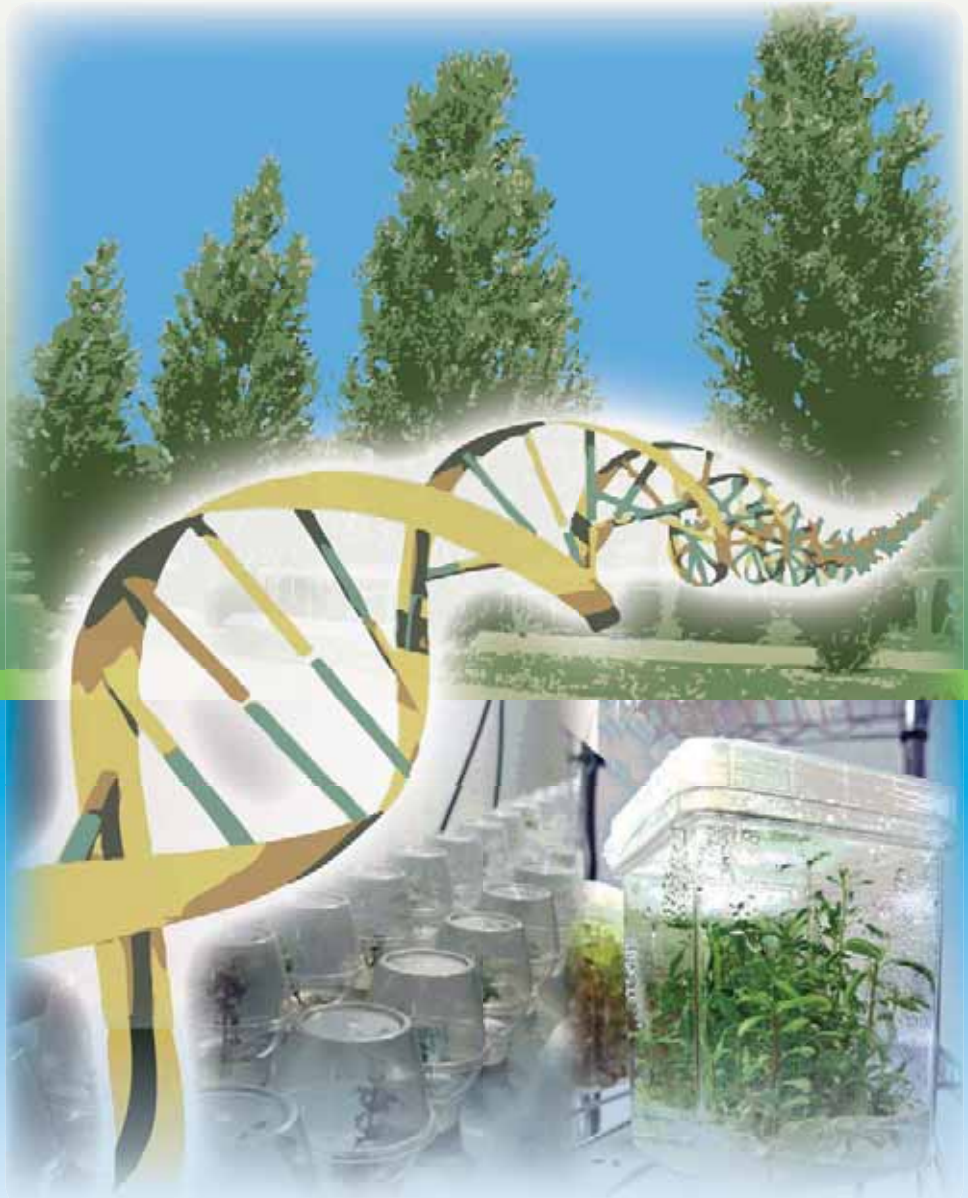
FORESTS
and
GENETICALLY MODIFIED TREES



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FORESTS
and
GENETICALLY MODIFIED TREES

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Foreword

The world's forests generate substantial economic benefits, and also provide countless ecosystem services and social, cultural and spiritual benefits on which it is more difficult to place an economic value. Aside from being a source of fibre, forests help protect air and water quality, mitigate climate change by storing vast quantities of carbon, and provide a home, temple and playground for many people.

Because of these intangible values and the long life span of trees, it is impossible to treat forests as a commodity within an agricultural model. The gap between forests and agricultural systems has become especially clear in the context of genetic engineering. The successful introduction of genetic engineering in agriculture, albeit for a limited number of traits and species, prompted forest scientists and managers to consider its use as a management and production tool in forestry. This subject has generated heated debates and violent reactions, which have often lacked the support of objective information. Furthermore, the existing scientific information has been contradictory, allowing for questions concerning its credibility. The competitive zeal of some biotechnology owners has added more fuel to the debate.

In the course of this debate, the term 'biotechnology' has often been wrongly used as synonymous with genetic engineering. In light of this confusion, the International Union of Forest Research Organizations (IUFRO) has formed a task force to address genetic engineering in forestry. Its mandate is to report and present factual information covering both the scientific and social dimensions of genetic engineering technology (also known as genetic transformation, gene technology or genetic modification). This publication, developed under the auspices of the IUFRO task force, has been created to present independent information gathered from the world's leading experts on the many facets of this subject. It is not intended to advocate any particular position towards genetic engineering or its application in forestry. Each chapter represents the views of its author(s), and not necessarily those of FAO or IUFRO.

The publication is divided into two parts. The first deals with the science of genetic engineering in forest trees: the position of genetic engineering in the biotechnology spectrum, how it is carried out, traits of interest, gene flow, genetic containment, integration of the technology in tree improvement programmes, and experience of its commercialization in China. The second part covers ethical, environmental, social, regulatory and trade aspects, and examines the technology's potential outside the realm of timber production.

We hope that the material presented here will assist readers in forming their own independent opinions on the place of genetic engineering in forestry.

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Acronyms

ABA	abscisic acid
AFLP	amplified fragment length polymorphism
APHIS	Animal and Plant Health Inspection Service, United States of America
BAC	bacterial artificial chromosome
BLAST	basic local alignment search tool
Bt	*Bacillus thuringiensis*
CAD	cinnamoyl alcohol dehydrogenase
CAld5H	coniferaldehyde 5-hydroxylase
CCoAOMT	caffeoyl-coenyzme A O-methyltransferase
CCR	cinnamyl CoA reductase
cDNA	complementary DNA
CLB	cottonwood leaf beetle (*Chrysomela scripta*)
COMT	caffeic acid O-methyltransferase
DD-PCR	differential display PCR
DDRT-PCR	differential display reverse transcriptase PCR
DMSO	dimethylsulphoxide
DNA	deoxyribonucleic acid
DNM	dominant negative mutation
EC	European Communities
ECS	*see:* γ-ECS
EEC	European Economic Community
EIS	environmental impact statement
ELISA	enzyme-linked immunosorbent assay
EPSPS	5-enolpyruvyl-3-phosphoshikimate synthase
EST	expressed sequence tag
EU	European Union
FDA	Food and Drug Administration of the USDA
G	guaiacyl [lignin]
GA	gibberellic acid
GIS	geographical information system
GMO	genetically modified organism
GR	glutathione reductase
GS	glutamine synthetase
GSH	glutathione
GSS	GSH synthetase
GST	glutathione S-transferase
GUS	β-glucuronidase [gene]

HGT	horizontal gene transfer
IAA	indole-3-acetic acid
IPR	intellectual property rights
MAB	marker-assisted breeding
MALDI-TOF	matrix-assisted laser desorption/ionization – time-of-flight mass spectrometer
MAR	matrix attachment region
MAS	marker-assisted selection
MAT	multiautonomous transformation system
mRNA	messenger RNA
NEPA	National Environmental Policy Act [of the United States of America]
PAT	phosphinothricin acetyltransferase
PCR	polymerase chain reaction
PEG	polyethylene glycol
PPT	phosphinothricin
qRT-PCR	quantitative reverse transcriptase-PCR
QTL	quantitative trait locus
QTN	quantitative trait nucleotide
RNA	ribonucleic acid
RNAi	RNA interference
ROS	reactive oxygen species
RT-PCR	reverse transcriptase-PCR
S	syringal [lignin]
SNP	single nucleotide polymorphism
SSH	suppression subtractive hybridization
TACCF	The American Chestnut Cooperators Foundation
TACF	The American Chestnut Foundation
TCE	trichloroethylene
T-DNA	Transfer-DNA
USDA	United States Department of Agriculture
USEPA	Unied States Environmental Protection Agency
VIGS	virus-induced gene silencing
XET	xyloglucan transglycosylase
γ-EC	γ-glutamylcysteine
γ-ECS	γ-glutamylcysteine synthetase