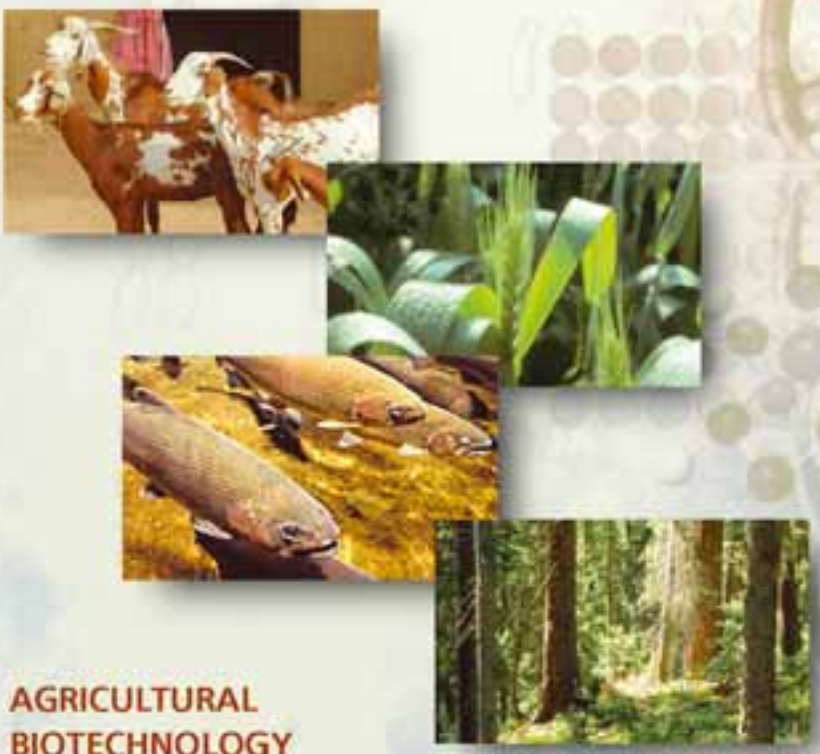
ISSN 0081-4539

2003–04

THE STATE OF FOOD AND AGRICULTURE



AGRICULTURAL BIOTECHNOLOGY

Meeting the needs of the poor?

Cover photos: *(top left)* Vincent Martin (FAO-EMPRES); *(middle right)* FAO/12337/F. Botts

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FAO Agriculture Series No. 35
ISSN 0081-4539

2003–04

THE STATE OF FOOD AND AGRICULTURE

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2004

Produced by the
Editorial Production and Design Group
Publishing Management Service
FAO

ISBN 92-5-105079-1

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Foreword

This edition of *The State of Food and Agriculture* explores the potential for agricultural biotechnology to address the needs of the world's poor and food-insecure. Agriculture continues to face serious challenges, including feeding an additional two billion people by the year 2030 from an increasingly fragile natural resource base. The effective transfer of existing technologies to poor rural communities and the development of new and safe biotechnologies can greatly enhance the prospects for sustainably improving agricultural productivity today and in the future. But technology alone cannot solve the problems of the poor and some aspects of biotechnology, particularly the socio-economic impacts and the food safety and environmental implications, need to be carefully assessed.

Developing biotechnology in ways that contribute to the sustainable development of agriculture, fisheries and forestry can help significantly in meeting the food and livelihood needs of a growing population. The study of genomics and molecular markers, for example, can facilitate breeding and conservation programmes and provide new tools in the fight against plant and animal diseases. It is clear from the survey of current and emerging applications of biotechnology in this report that biotechnology encompasses far more than genetic engineering. But it is the ability to move genes between unrelated species that gives genetic engineering its enormous power and elicits such profound concern. FAO recognizes the need for a balanced and comprehensive approach to biotechnological development, taking into consideration the opportunities and risks.

Biotechnology offers opportunities to increase the availability and variety of food, increasing overall agricultural productivity while reducing seasonal variations in food supplies. Through the introduction of pest-resistant and stress-tolerant crops, biotechnology could lower the risk of crop failure under difficult biological and climatic conditions. Furthermore, biotechnology could help reduce environmental damage caused by toxic agricultural chemicals. Following a first generation of genetically engineered crops, which aimed primarily at reducing production constraints and costs, a second generation now targets the bio-availability of nutrients and the nutritional quality of products. Examples are found in the production of varieties of rice and canola that contain appreciable amounts of beta-carotene. This precursor of vitamin A is in short supply in the diets of many, particularly in the developing world where it could help to alleviate or reduce chronic vitamin A deficiencies. Research is under way to raise levels of other vitamins, minerals and proteins in crops, such as potatoes and cassava.

This issue of *The State of Food and Agriculture* reviews the historical record of agricultural research in promoting economic growth and food security. The Green Revolution, which lifted millions of people out of poverty, came about through an international programme of public-sector agricultural research specifically aimed at creating and transferring technologies to the developing world as free public goods. The Gene Revolution, by contrast, is currently being driven primarily by the private sector, which naturally focuses on developing products for large commercial markets. This raises serious questions about the type of research that is being performed and the likelihood that the poor will benefit.

The emerging evidence on the economic impact of transgenic crops surveyed in this report suggests that resource-poor smallholders in developing countries can benefit in terms of both enhanced incomes and reduced exposure to toxic agricultural chemicals. But so far only a few farmers in a few developing countries are reaping these benefits. Neither the private nor the public sector has invested significantly in new genetic technologies for the so-called "orphan crops" such as cowpea, millet, sorghum and tef that are critical for the food supply and livelihoods of the world's poorest people. Other barriers that prevent the poor

from accessing and fully benefiting from modern biotechnology include inadequate regulatory procedures, complex intellectual property issues, poorly functioning markets and seed delivery systems, and weak domestic plant breeding capacity.

FAO is well aware of the potential environmental and food safety risks posed by certain aspects of biotechnology, particularly genetically modified organisms (GMOs). This issue of *The State of Food and Agriculture* reviews the latest scientific evidence contained in several independent, authoritative reports from around the world. Reports from the International Council for Science, the Nuffield Council on Bioethics, the United Kingdom GM Science Review Panel and numerous national academies of science form the basis of this review. The scientific evidence concerning the environmental and health impacts of genetic engineering is still emerging. Scientists generally agree that the transgenic crops currently being grown and the foods derived from them are safe to eat, although little is known about their long-term effects. There is less scientific agreement on the environmental impacts of transgenic crops. Scientists generally agree on the nature of the potential environmental risks, although they differ regarding their likelihood and consequences. There is strong consensus among scientists concerning the need for a case-by-case evaluation that considers the potential benefits and risks of individual GMOs compared with alternative technologies. The legitimate concerns for the safety of each transgenic product must be addressed prior to its release. Careful monitoring of the post-release effects of these products is essential.

With this report, I wish to take the opportunity to assure the international community that, through holistic and multidisciplinary scientific approaches of risk evaluation, including risk assessment, risk management and risk communication, FAO will continue to address all issues of concern to its constituents regarding biotechnology and its effects on human, plant and animal health. In view of the importance of harmonizing regulations related to the testing and releasing of GMOs, FAO will continue, at the national, subregional and regional levels, to strengthen its normative and advisory work, in coordination and cooperation with other international organizations. I am particularly pleased to note that the Codex Alimentarius Commission, for which FAO and the World Health Organization (WHO) jointly provide the secretariat, has recently adopted landmark agreements on principles for the evaluation of food derived from modern biotechnologies and on guidelines for the conduct of food safety assessment of foods derived from recombinant-DNA plants as well as from foods produced using recombinant-DNA micro-organisms. These principles and guidelines, when properly implemented, will enhance capacities to assess the risks of transferring toxins from one life form to another, of creating new toxins or of transferring allergenic compounds from one species to another.

FAO will continue to provide member countries with objective, science-based information and analysis regarding biotechnology and its applications in crops, livestock, fisheries and forestry. FAO technical cooperation will encompass advising Member Governments on regulatory issues including harmonization at regional and international levels, offering legal advice for the establishment of any required regulatory bodies, improving national capacity for risk assessment, mobilizing donor funding and cooperating with other relevant organizations.

I therefore appeal to the international community to join FAO in its continuing efforts towards alleviating poverty and hunger through the promotion of agricultural development, the improvement of nutrition and the pursuit of food security throughout the world. With your help, success is at the end of our efforts, perseverance and commitment.

Jacques Diouf
FAO DIRECTOR-GENERAL

Preface

The State of Food and Agriculture 2003–04 has a new look and a new format that we hope you find attractive, informative and stimulating. Beginning with this issue, the report focuses on one important theme in agricultural and economic development each year, providing an in-depth analysis of its socio-economic implications and exploring policy options better to meet the needs of poor people in developing countries. We expect these thematic reports to make a significant contribution to the global debate on agricultural and economic development among policy-makers, the research community, development professionals and civil society. The theme this year is "Agricultural biotechnology: meeting the needs of the poor?" In subsequent issues, it is planned to address international trade, domestic agricultural markets and related global issues that influence the livelihoods and food security of the poor.

This new edition of the *State of Food and Agriculture* continues our tradition of providing a succinct overview of the current food and agriculture situation at the world and regional levels, including the latest estimates of the number of undernourished people; commodity production, trade and price trends; and agricultural investment, support and external assistance. The print version of this world and regional overview is supplemented periodically throughout the year with more comprehensive and timely regional reports. These regional reports can be accessed from our Web site at www.fao.org/es/esa. In addition, we introduce a new series of national agricultural and food security indicators with this year's report. These indicators will evolve over the coming years to provide a tool for monitoring the state of food and agriculture across countries and over time.

The State of Food and Agriculture 2003–04 is the first to be produced under a new management team comprising Prabhu Pingali, Director of the Agricultural and Development Economics Division (ESA), Randy Stringer, Chief of the Comparative Agricultural Development Service, and Terri Raney, Editor and Senior Economist for *The State of Food and Agriculture*. The Director-General of FAO, Jacques Diouf, and the Assistant Director-General of the Economic and Social Department, Hartwig de Haen, were instrumental in this effort to revitalize the report. The team is also grateful for the advice and support provided by the report's External Advisory Board: Walter P. Falcon (Chair United States), Bina Agarwal (India), Kym Anderson (Australia), Simeon Ehui (Côte d'Ivoire), Franz Heidhues (Germany) and Eugenia Muchnik (Chile).

The *State of Food and Agriculture* team is particularly keen to hear your reactions to this report and your suggestions for future issues. We look forward to hearing from you at SOFA@fao.org.

Terri Raney
Editor
The State of Food and Agriculture

Acknowledgements

The State of Food and Agriculture 2003–04 was prepared by a team from the Comparative Agricultural Development Service, led by Terri Raney. Team members included Jakob Skoet, André Croppenstedt, Annelies Deuss, Fulvia Fiorenzi, Slobodanka Teodosijevic and Stefano Trento. Secretarial support was provided by Stella Di Lorenzo and Paola Di Santo. General supervision was provided by Randy Stringer, Chief, Comparative Agricultural Development Service, and Prabhu Pingali, Director, Agricultural and Development Economics Division.

Part I, "Agricultural biotechnology: meeting the needs of the poor?", was written by Terri Raney with contributions from many FAO technical units and international experts. Background research for Part I was conducted by Joel Cohen, José Falck-Zepeda, Thomas Hoban, John Komen, Anwar Naseem, Prabhu Pingali, Carl Pray, Terri Raney and Greg Traxler. Many of these papers have been published in the ESA Working Paper series and can be found at www.fao.org/es/esa. The FAO Inter-Departmental Working Group on Biotechnology provided additional background material, draft texts, reviews and financial support. The report benefited greatly from the support of the Working Group, in particular James Dargie, Chair. Full bibliographic references are supplied at the end of the report. In addition to the lead author, the main contributors to the chapters were as follows:

Chapter 2 (What is agricultural biotechnology?). Draft texts were contributed by Jonathan Robinson, James Dargie and Irene Hoffman. Additional material was taken from the background papers for the FAO Electronic Forum on Biotechnology in Food and Agriculture prepared by John Ruane. Additional inputs were provided by Devin Bartley, Elcio Guimarães, Keith Hammond (retired), Hoan Le, Prakash Shetty and Pierre Sigaud. The following international experts generously contributed summaries of their ongoing biotechnology research: Mike Gale of the John Innes Centre on synteny; Miftahudin, Miguel Rodriguez Milla, Kathleen Ross and J. Perry Gustafson variously of Bogor Agricultural University, the University of Missouri and the United States Department of Agriculture on aluminium tolerance; and Tom Hash of the International Crops Research Institute for the Semi-Arid Tropics on marker-assisted selection for downy mildew resistance in pearl millet.

Chapter 3 (Green to Gene). Background papers were prepared by Prabhu Pingali and Terri Raney, Carl Pray and Anwar Naseem, and Greg Traxler. Norman Borlaug and M.S. Swaminathan wrote special contributions for this chapter.

Chapter 4 (Economic impacts). Greg Traxler prepared a background paper and additional inputs were contributed by the following international experts: Kym Anderson, Richard Bennett, Liborio Cabanilla, Matin Qaim and Eric Tollens.

Chapter 5 (Concerns). Christina Devorshak, Daniele Manzella and Andrew Speedy contributed texts and background material. Alessandro Pellegrineschi and David Hoisington of the International Maize and Wheat Improvement Center wrote the box on the "clean gene" transformation technique and Allison Snow of Ohio State University wrote the box on the ecological assessment of transgenic crops.

Chapter 6 (Public attitudes). Thomas Hoban prepared a background paper on public opinion research and Janice Albert contributed the text on labelling.

Chapter 7 (Research policy). Background papers were prepared by Carl Pray and Anwar Naseem, Prabhu Pingali and Terri Raney, and Greg Traxler.

Chapter 8 (Capacity building). Background papers were prepared by José Falck-Zepeda, Joel Cohen and John Komen, and by Fulvia Fiorenzi.

Chapter 8 (Capacity building). Kakoli Ghosh contributed draft text with additional inputs from Andrea Sonnino.

Chapter 9 (Conclusions). Randy Stringer prepared the draft text for this chapter.

Part II, "World and regional review: facts and figures", was prepared by Annelies Deuss and Jakob Skoet.

Part III, "Statistical annex", was prepared by André Croppenstedt, Annelies Deuss and Randy Stringer.

The team is particularly grateful to the *State of Food and Agriculture* External Advisory Board, comprising Walter Falcon (Chair), Bina Agarwal, Kym Anderson, Simeon Ehui, Franz Heidhues and Eugenia Muchnik, who provided valuable guidance on the scope and focus of the report. External reviews by Hermann Waibel, Diemuth Pemsl and Sarah Hearne are gratefully acknowledged.

The report benefited from the work of the editors, designers and layout artists of the FAO Publishing Management Service.

Glossary

AATF	African Agricultural Technology Foundation
AEBC	United Kingdom Agriculture and Environment Biotechnology Commission
AGERI	Agricultural Genetic Engineering Research Institute – Egypt
AI	artificial insemination
AIA	Advance Informed Agreement
Bt	*Bacillus thuringiensis*
CAAS	Chinese Academy of Agricultural Sciences
CAC	Codex Alimentarius Commission
CAMBIA	Center for the Application of Molecular Biology to International Agriculture
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
COPERSUCAR	Cooperative of Cane, Sugar and Ethanol Producers of the State of São Paulo, Brazil
D&PL	Delta and Pine Land Company
DEA	data envelopment analysis
DFID	Department for International Development – United Kingdom
DNA	deoxyribonucleic acid
EGR	evergreen revolution
ELISA	enzyme-linked immunosorbent assay
Embrapa	Brazilian Agricultural Research Corporation
GAO	United States Government Accounting Office
GDP	gross domestic product
GEF	Global Environment Facility

GEO	genetically engineered organism
GIEWS	Global Information and Early Warning System on Food and Agriculture
GM	genetically modified
GMO	genetically modified organism
GNP	gross national product
GREP	Global Rinderpest Eradication Programme
HT	herbicide tolerant
IAEA	International Atomic Energy Agency
IARC	International Agricultural Research Centre
IBS	ISNAR Biotechnology Service
ICGEB	International Centre for Genetic Engineering and Biotechnology
ICCO	International Cocoa Organization
ICO	International Coffee Organization
ICPM	Interim Commission on Phytosanitary Measures
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICSU	International Council for Science
IFPRI	International Food Policy Research Unit
IPPC	International Plant Protection Convention
IPR	intellectual property rights
IRRI	International Rice Research Institute
ISA	International Sugar Agreement
ISAAA	International Service for the Acquisition of Agri-biotech Applications
ISNAR	International Service for National Agricultural Research
ISPM	international standards for phytosanitary measures
LMO	living modified organism
MAS	marker-assisted selection
MOET	multiple ovulation followed by embryo transfer
MTA	material transfer agreement

NARS	national agricultural research systems
NAS	National Academy of Sciences
NGO	non-governmental organization
NPB	National Programme for Biotechnology
NRC	National Research Council – United States
NTSBD	National Taskforce for Sustainable Biotechnological Development
OECD	Organisation for Economic Co-operation and Development
OIE	World Organisation for Animal Health (formerly International Office of Epizootics)
PARC	Pan African Rinderpest Eradication Campaign
PCR	polymerase chain reaction
PPP	purchasing power parity
R&D	research and development
RFLP	restriction fragment length polymorphism
RNA	ribonucleic acid
RR	RoundupReady®
SIDA	Swedish International Development Cooperation Agency
SPS	Sanitary and Phytosanitary Measures
TBT	Technical Barriers to Trade
TFP	total factor productivity
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WFP	Wold Food Programme
WHO	World Health Organization
WTO	World Trade Organization

Explanatory note

The statistical information in this issue of *The State of Food and Agriculture* has been prepared from information available to FAO up to November 2003.

Symbols

The following symbols are used:

– = none or negligible (in tables)
... = not available (in tables)
$ = US dollars

Dates and units

The following forms are used to denote years or groups of years:

2001/02 = a crop, marketing or fiscal year running from one calendar year to the next
2001–02 = the average for the two calendar years

Unless otherwise indicated, the metric system is used in this publication.
"Billion" = 1 000 million.

Statistics

Figures in statistical tables may not add up because of rounding. Annual changes and rates of change have been calculated from unrounded figures.

Production indices

The FAO indices of agricultural production show the relative level of the aggregate volume of agricultural production for each year in comparison with the base period 1989–91. They are based on the sum of price-weighted quantities of different agricultural commodities after the quantities used as seed and feed (similarly weighted) have been deducted. The resulting aggregate therefore represents disposable production for any use except seed and feed.

All the indices, whether at the country, regional or world level, are calculated by the Laspeyres formula. Production quantities of each commodity are weighted by 1989–91 average international commodity prices and summed for each year. To obtain the index, the aggregate for a given year is divided by the average aggregate for the base period 1989–91.

Trade indices

The indices of trade in agricultural products are also based on the base period 1989–91. They include all the commodities and countries shown in the *FAO Trade Yearbook*. Indices of total food products include those edible products generally classified as "food".

All indices represent changes in current values of exports (free on board [f.o.b.]), and imports (cost, insurance, freight [c.i.f.]), expressed in US dollars. When countries report imports valued at f.o.b., these are adjusted to approximate c.i.f. values.

Volumes and unit value indices represent the changes in the price-weighted sum of quantities and of the quantity-weighted unit values of products traded between countries. The weights are, respectively, the price and quantity averages of 1989-91 which is the base reference period used for all the index number series currently computed by FAO. The Laspeyres formula is used to construct the index numbers.