

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

Copies of FAO publications can be requested from:

SALES AND MARKETING GROUP
Information Division
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00100 Rome, Italy

E-mail: publications-sales@fao.org
Fax: (+39) 06 57053360
Web site: <http://www.fao.org>

2003-04

FAO Agriculture Series No. 35

ISSN 0081-4539

THE STATE OF FOOD AND AGRICULTURE

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

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention or omission of specific companies, their products or brand names does not imply any endorsement or judgement by the Food and Agriculture Organization of the United Nations. Every effort has been made to locate the copyright holders of the two fisheries and forestry photographs used in this publication. If you have information pertaining to such copyright, please contact the address below.

ISBN 92-5-105079-1

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders. Applications for such permission should be addressed to:

Chief
Publishing Management Service
Information Division
FAO
Viale delle Terme di Caracalla, 00100 Rome, Italy
or by e-mail to:
copyright@fao.org

© FAO 2004

Contents

Foreword	vii
Preface	ix
Acknowledgments	x
Glossary	xii
Explanatory note	xv

PART I

Agricultural biotechnology: meeting the needs of the poor?

SECTION A: FRAMING THE DEBATE

1. Can biotechnology meet the needs of the poor?	3
Introduction and overview	3
Key lessons from the report	5
Summary of the report	5
2. What is agricultural biotechnology?	8
Understanding, characterizing and managing genetic resources	9
Breeding and reproducing crops and trees	13
Breeding and reproducing livestock and fish	18
Other biotechnologies	21
Conclusions	22
3. From the Green Revolution to the Gene Revolution	25
The Green Revolution: research, development, access and impact	27
The Gene Revolution: a changing paradigm for agricultural R&D	31
Conclusions	38

SECTION B: THE EVIDENCE SO FAR

4. Economic impacts of transgenic crops	41
Sources of economic impacts	41
Global adoption of insect-resistant cotton	43
Economic impacts of transgenic cotton	44
Conclusions	56
5. Health and environmental impacts of transgenic crops	58
Food safety implications	58
International standards for food safety analysis	61
Environmental implications	66
Environmental impact assessment	72
International environmental agreements and institutions	72
Conclusions	76
6. Public attitudes to agricultural biotechnology	77
Benefits and risks of biotechnology	77
Support for different applications of biotechnology	78
Personal expectations of biotechnology	80
Moral and ethical concerns	81
Consumer-oriented applications	81
Food labelling and biotechnology	83
Conclusions	84

SECTION C: MAKING BIOTECHNOLOGY WORK FOR THE POOR

7. Research and research policy for the poor	87
Promoting access to biotechnology applications	87
Promoting public- and private-sector research for the poor	89
Conclusions	98
8. Capacity building for biotechnology in food and agriculture	99
National capacities in agricultural biotechnology	99
International capacity-building activities in agricultural biotechnology	100
FAO role and assistance to member countries	101
Challenges in capacity building for agricultural biotechnology	101
Next steps	103
9. Conclusions: meeting the needs of the poor	104

PART II**World and regional review: facts and figures**

1. Trends in undernourishment	109
2. Food emergencies and food aid	111
3. Crop and livestock production	114
4. World cereal supply situation	120
5. International commodity price trends	121
6. Agricultural trade	126
7. External assistance to agriculture	131
8. Agricultural capital stock	134
9. Fisheries: production, disposition and trade	136
10. Forestry	141

PART III**Statistical annex**

Notes on the annex tables	149
Table A1 Countries and territories used for statistical purposes in this publication	155
Table A2 Food security and nutrition	157
Table A3 Agricultural production and productivity	163
Table A4 Population and labour force indicators	169
Table A5 Land use	175
Table A6 Trade indicators	182
Table A7 Economic indicators	188
Table A8 Total factor productivity	194

References	199
Special chapters of <i>The State of Food and Agriculture</i>	205
Selected publications	207
SOFA-DB CD-ROM: installation and start-up guidelines	209

SPECIAL CONTRIBUTIONS

- | | |
|---|----|
| 1. Feeding 10 billion people – our twenty-first century challenge
<i>Norman E. Borlaug</i> | 26 |
| 2. Towards an evergreen revolution
<i>M.S. Swaminathan</i> | 28 |

BOXES

- | | |
|--|-----|
| 1. Scope of the report | 4 |
| 2. Defining agricultural biotechnology | 8 |
| 3. Induced mutation-assisted breeding | 10 |
| 4. DNA from the beginning | 11 |
| 5. Synteny is life! | 12 |
| 6. Molecular markers and marker-assisted selection for pearl millet in India | 14 |
| 7. Micropropagation of disease-free banana in Kenya | 15 |
| 8. Agriculture on acid soils: improving aluminium tolerance in cereals | 16 |
| 9. The “protato”: help for the poor or a Trojan horse? | 18 |
| 10. State of the World’s Animal Genetic Resources | 19 |
| 11. Biotechnology: ridding the world of rinderpest | 22 |
| 12. Public goods and intellectual property rights | 32 |
| 13. Projecting the economic impacts of “Golden Rice” in the Philippines | 42 |
| 14. What is Bt cotton and why is it grown? | 44 |
| 15. Herbicide-tolerant soybeans in Argentina and the United States | 50 |
| 16. Costs of not adopting Bt cotton in West Africa | 55 |
| 17. The nature of risk and risk analysis | 59 |
| 18. International standards to facilitate trade | 60 |
| 19. Health and environmental concerns in conventional plant breeding | 61 |
| 20. “Clean gene” transformation at CIMMYT | 62 |
| 21. Genetically modified crops as animal feed | 64 |
| 22. Environmental concerns regarding genetically modified animals | 68 |
| 23. An ecologist’s view of gene flow from transgenic crops | 70 |
| 24. Does Bt maize kill monarch butterflies? | 71 |
| 25. Asking the right questions | 78 |
| 26. Can biotechnology research address the needs of poor farmers?
The role of participatory agricultural research | 91 |
| 27. FAO and capacity building in agricultural biotechnology in Bangladesh | 102 |

TABLES

- | | |
|--|-----|
| 1. An agricultural biotechnology timeline | 10 |
| 2. Genetic variation in concentrations of iron, zinc, beta-carotene
and ascorbic acid found in germplasm of five staple foods, dry weight basis | 17 |
| 3. Estimated crop biotechnology research expenditures | 33 |
| 4. Field trials by crop and region | 34 |
| 5. Bt and Bt/HT cotton area, 2001 | 46 |
| 6. Adoption of Bt cotton by farmers in the United States by state, 1998–2001 | 46 |
| 7. Performance differences between Bt and conventional cotton | 48 |
| 8. Distribution of benefits of Bt cotton adoption by size of farm
or income class in China, 1999 | 52 |
| 9. Adoption of Bt cotton and geographical distribution of pest problems
in Mexico’s major cotton-producing areas, 1997–98 | 53 |
| 10. Estimates of economic benefit distribution, Comarca Lagunera region
of Mexico, 1997 and 1998 | 54 |
| 11. Values and assets of public and private sectors in agri-biotechnology research | 95 |
| 12. Per capita shipments of food aid in cereals | 112 |

FIGURES

1. Transgenic crop field trials, by country group	35
2. GM crops traits tested in industrialized countries, 1987–2000	35
3. GM crops traits tested in less developed countries, 1987–2000	36
4. Global area of transgenic crops	36
5. Global area of transgenic crops in 2003, by country	37
6. Global area of transgenic crops in 2003, by crop	37
7. Global area of transgenic crops in 2003, by trait	38
8. Pesticide applications for budworm–bollworm complex, selected states of the United States, 1992–2001	47
9. Benefits from adopting Bt cotton in the United States, 1996–98	47
10. The benefits of biotechnology outweigh the risks	79
11. Do you support these biotechnology applications?	80
12. Biotechnology will benefit people like me	81
13. Modifying the genes of plants or animals is wrong	82
14. Would you buy nutritionally enhanced foods?	82
15. Undernourished population by region, 1999–2001	109
16. Number of undernourished people in developing countries, by region	110
17. Proportion of population undernourished in developing countries, by region	110
18. Recipients of food aid in cereals	113
19. Recipients of food aid in non-cereals	113
20. Changes in crop and livestock production, total and per capita	115
21. Changes in crop and livestock production, by region	116
22. Long-term trend in per capita food production	118
23. World cereal production and utilization	120
24. World cereal stocks and stocks-to-utilization ratio	121
25. Commodity price trends	122
26. Annual change in value of global agricultural exports	126
27. Global agricultural exports	127
28. Agricultural imports and exports, by region	127
29. Share of world agricultural exports, by region	130
30. Commitments of external assistance to agriculture, by main recipient regions	131
31. Long-term trend in external assistance to agriculture, 1974–2000	132
32. Share of concessional assistance in total assistance to agriculture	132
33. External assistance to agriculture per agricultural worker	133
34. External assistance to agriculture per agricultural worker according to prevalence of undernourishment, 1998–2000	133
35. Agricultural capital stock per agricultural worker, by region	134
36. Agricultural capital stock per agricultural worker in developing countries by prevalence of undernourishment, 1998–2000	135
37. World fish production, China and rest of the world	137
38. Trade in fish and fishery products, developed and developing countries	138
39. Trade in fish and fishery products in developing countries	138
40. Per capita fish supply from capture and aquaculture, China and rest of the world	140
41. Per capita fish supply by region, 1997–99	140
42. World roundwood production	142
43. Roundwood production, by developing country region	143
44. Forest area in 2000	144
45. Share of land area covered by forests in 2000	145
46. Average annual change in forest cover, 1990–2000	145

MAP

1. Countries facing food emergencies	111
--------------------------------------	-----

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.

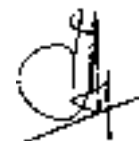
FAO is well aware of the potential environmental and food safety risks posed by certain aspects of biotechnology, particularly genetically modified organisms (GMOs). This issue of *The State of Food and Agriculture* reviews the latest scientific evidence contained in several independent, authoritative 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 Pemsler 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	<i>Bacillus thuringiensis</i>
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	World 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.