

# The State of the World's

# **Plant Genetic Resources**

# for Food and Agriculture





Agriculture Organization

# THE STATE OF THE WORLD'S PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Rome, 1997 The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The word "countries" appearing in the text refers to countries, territories and areas without distinction. The designations "developed" and "developing" countries are intended for statistical convenience and do not necessarily express a judgement about the stage reached by a particular country or area in the development process. The opinions expressed in the articles by contributing authors are not necessarily those of FAO.

All rights reserved. Reproduction and dissemination of material in this publication for non-commercial educational purpose are allowed on condition that acknowledgement of the source is given whenever such material is used. Reproduction of this publication in its entirely or of extensive parts thereof, and any commercial use thereto are subject to the prior permission of the copyright owner. Applications for such permission, with a statement of the purpose and extent of the reproduction involved, should be addressed in writing to the Director, Information Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00100 Rome, Italy.

#### © FAO 1997



### Contents

PREFACE	1
CHAPTER 1 THE STATE OF DIVERSITY	13
CHAPTER 2 THE STATE OF <i>IN SITU</i> MANAGEMENT	51
CHAPTER 3 THE STATE OF <i>EX SITU</i> CONSERVATION	83
CHAPTER 4 THE STATE OF UTILIZATION	137
CHAPTER 5 THE STATE OF NATIONAL PROGRAMMES, TRAINING NEEDS AND LEGISLATION	197
CHAPTER 6 THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION	233
CHAPTER 7 ACCESS TO PLANT GENETIC RESOURCES, SHARING OF BENEFITS DERIVED FROM THEIR US AND THE REALIZATION OF FARMERS' RIGHTS	SE, 275
ANNEX 1	
ANNEX 1-1 STATE OF THE ART: GENETIC DIVERSITY	313
ANNEX 1-2 STATE OF THE ART: CONSERVATION	337
ANNEX 1-3 STATE OF THE ART: UTILIZATION	369
ANNEX 1-4 STATE OF THE ART: LEGAL AND ECONO	MIC 393
ANNEX 2 STATE OF DIVERSITY OF MAJOR AND MINOR C	ROPS 411
APPENDIX 1 STATUS BY COUNTRY OF NATIONAL LEGISLATIC PROGRAMMES AND ACTIVITIES FOR PGRFA	ON, 455
APPENDIX 2 LIST OF MAJOR GERMPLASM ACCESSIONS BY CROP AND INSTITUTE	463
APPENDIX 3 REGIONS OF DIVERSITY OF CULTIVATED PLANTS	5 501





Contents in detail

### **ACRONYMS AND ABBREVIATIONS**

PREFACE		1
CHAPTER THE STAT	R 1 TE OF DIVERSITY	13
1.1	INTRODUCTION	13
1.2	DIVERSITY WITHIN AND BETWEEN PLANT SPECIES1.2.1The diversity of plant species1.2.2Diversity within species	<b>14</b> 14 18
1.3	ORIGINS OF PGRFA AND THE INTERDEPENDENCE OF COUNTRIES ON PGRFA	20
1.4	THE VALUE OF PLANT GENETIC RESOURCES FOR         FOOD AND AGRICULTURE         1.4.1       The types of value of genetic resources and genetic diversity	24 24
	<ul><li>1.4.2 The value of genetic diversity to small farmers</li><li>1.4.3 The value of plant genetic resources for food and agriculture in modern varieties</li></ul>	25 27
	1.4.4 Indicators of the monetary value of PGRFA to food and agricultural production	29
1.5	GENETIC VULNERABILITY AND GENETIC EROSION 1.5.1 Genetic vulnerability 1.5.2 Genetic erosion	<b>30</b> 30 33
1.6	ASSESSMENT OF MAJOR NEEDS AN INTEGRATED APPROACH TO THE CONSERVATION AND UTILIZATION OF PGRFA	40
CHAPTER THE STAT	R 2 TE OF <i>IN SITU</i> MANAGEMENT	51
2.1	INTRODUCTION	51
2.2	INVENTORIES AND SURVEYS	52
2.3	CONSERVATION OF PGRFA IN PROTECTED AREAS	54
2.4	ECOSYSTEM MANAGEMENT FOR CONSERVATION OF PGRFA OUTSIDE PROTECTED AREAS	58
2.5	ON-FARM CONSERVATION2.5.1Examples of on-farm conservation2.5.2Strengthening on-farm conservation and development	<b>59</b> 60 66
2.6	ASSESSMENT OF MAJOR NEEDS FOR IN SITU MANAGEMENT OF PGRFA	72



CHAPTE THE STA	r 3 TE OF <i>EX SITU</i> CONSERVATION	83
3.1	INTRODUCTION	83
3.2	COLLECTING	86
3.3	TYPES OF COLLECTIONS3.3.1Crop species covered3.3.2Types of material stored3.3.3Sources of material in genebanks3.3.4Coverage of collections and remaining gaps	<b>90</b> 90 94 95 97
3.4	STORAGE FACILITIES3.4.1Long-, medium- and short-term seed genebank facilities3.4.2Field genebanks and <i>in vitro</i> facilities	<b>98</b> 100 106
3.5	SECURITY OF STORED MATERIAL3.5.1State of duplication3.5.2The need for regeneration	111 111 111
3.6	DOCUMENTATION AND CHARACTERIZATION3.6.1Documentation3.6.2Characterization	<b>117</b> 117 122
3.7	GERMPLASM MOVEMENT	125
3.8	BOTANICAL GARDENS3.8.1Conservation facilities and statistics3.8.2Documentation and germplasm exchange	<b>126</b> 126 127
3.9	ASSESSMENT OF MAJOR EX SITU NEEDS	128
CHAPTE THE STA	R 4 TE OF UTILIZATION	137
4.1	INTRODUCTION	137
4.2	UTILIZATION AND MAJOR CONSTRAINTSTO THE USE OF CONSERVED PGRFA4.2.1Distribution and utilization of plant genetic resources4.2.2Constraints to germplasm use	<b>140</b> 140 144
4.3	REVIEW OF UTILIZATION ACTIVITIES4.3.1Evaluation of PGRFA4.3.2Pre-breeding (genetic enhancement)4.3.3Plant breeding and other crop improvement programmes4.3.4Seed supply programmes4.3.5Marketing and processing	148 148 151 153 172 176
4.4	DEPLOYMENT OF GENETIC DIVERSITY INAGRICULTURAL PRODUCTION SYSTEMS4.4.1Introduction4.4.2Breeding for resistance to pests and diseases4.4.3Breeding for other traits	<b>177</b> 177 180 182
4.5	ASSESSMENT OF MAJOR NEEDS TO IMPROVE THE UTILIZATION OF PLANT GENETIC RESOURCES	183



197

233

#### CHAPTER 5 THE STATE OF NATIONAL PROGRAMMES, TRAINING NEEDS AND LEGISLATION

5.1	INTRO	DUCTION	197
5.2	NATION 5.2.1 5.2.2 5.2.3 5.2.4 5.2.5	VAL PROGRAMMES Purpose and basic functions of national programmes Types of national programmes State of development of national programmes Funding of national programmes Role of the public, private and informal sectors	198 198 200 203 207 208
5.3	TRAINI	NG	211
5.4	NATION 5.4.1 5.4.2 5.4.3 5.4.4 5.4.5	AL LEGISLATION Access to genetic resources Phytosanitary regulations Seed regulations Plant breeders' rights Other policies which affect the conservation and utilization of PGRFA	214 214 216 218 220 222
5.5		MENT OF THE MAJOR NEEDS FOR NATIONAL AMME DEVELOPMENT, TRAINING AND LEGISLATION	223

#### CHAPTER 6 THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION

6.1	INTROD	UCTION	233
6.2	<b>COLLAB</b> 6.2.1 6.2.2 6.2.3 6.2.4	ORATION AT REGIONAL AND SUB-REGIONAL LEVELS Regional and sub-regional networks Crop-specific networks Regional review of plant genetic resources networks and associated crop networks Sub-regional collaboration for <i>ex situ</i> collections	<b>235</b> 235 237 237 245
6.3		ATIONAL PROGRAMMES FAO International Agricultural Research Centres Other intergovernmental and international organizations Bilateral programmes Programmes of private foundations and non-governmental organizations	<b>247</b> 247 248 251 252 253
6.4	INTERN 6.4.1 6.4.2 6.4.3	ATIONAL AGREEMENTS The FAO International Undertaking on Plant Genetic Resources The Convention on Biological Diversity Other international agreements	<b>254</b> 254 255 255
6.5		DBAL SYSTEM FOR THE CONSERVATION ILIZATION OF PGRFA International Network of <i>Ex Situ</i> Collections International Code of Conduct for Plant Germplasm Collecting and Transfer	<b>256</b> 259 261

	Conten	nts in detail	
	6.5.3 6.5.4		262 262
6.6		MENT OF MAJOR NEEDS TO IMPROVE ATIONAL COLLABORATION	265
THE SHA	TO PLAN ARING O	NT GENETIC RESOURCES, OF BENEFITS DERIVED FROM THEIR USE LATION OF FARMERS' RIGHTS	275
7.1	INTRO	DUCTION	275
7.2	THE LEG	GAL AND POLICY FRAMEWORK	276
7.3	7.3.1	ATE OF ACCESS TO PLANT GENETIC RESOURCES Exchange of plant genetic resources from <i>in situ</i> conditions and <i>ex situ</i> collections	<b>280</b> 280
	7.3.2 7.3.3 7.3.4	Exchange of improved crop varieties Restrictions on access Regulation of access	282 284 285
7.4		TS DERIVED FROM THE CONSERVATION TILIZATION OF PGRFA Global benefits derived from the conservation	287
	7.4.2 7.4.3	and utilization of PGRFA The state of benefit-sharing between countries The state of benefit-sharing with regard	287 289
		to farmers and communities	295
7.5	FINANG	CING PGRFA ACTIVITIES	297
7.6	IMPLEM	MENTATION OF FARMERS' RIGHTS	299
7.7	CONCL	USIONS	301
-	DS FOR /	ANALYSING AND ASSESSING	313
		SITY, EROSION AND VULNERABILITY	
			313
AI	GEN A1-1 A1-1	THODS FOR ASSESSING OR ANALYSINGNETIC DIVERSITY1.2.1Taxonomic analysis of inter-species diversity1.2.2Analysis of intra-specific diversity1.2.3Use of indigenous and traditional knowledge	<b>315</b> 315 315
		<ul> <li>1.2.3 Use of indigenous and traditional knowledge for analysing useful diversity</li> <li>1.2.4 Transfer of molecular marker technologies to developing countries</li> </ul>	320 320
A1-	ASS	ME USEFUL APPLICATIONS OF METHODS FOR ESSING GENETIC DIVERSITY 1.3.1 Guiding collecting priorities or designation	322
		of <i>in situ</i> or on-farm conservation areas 1.3.2 Use of genetic diversity assessments to monitor	322
	A1-1	genetic erosion 1.3.3 Determining the evolutionary history of crops	323 324

	100	00000000	
	Contents in de	tail	
	A1-1.3.4	Use of genetic diversity assessments to guide	225
	A1-1.3.5	the management of germplasm collections Genetic diversity analysis and	325
	A1-1.3.6	germplasm utilization Use of genetic diversity assessments to	326
	A1-1.3.7	monitor genetic vulnerability Use of genetic diversity assessments to	328
		monitor the transfer of genetic resources	329
ANNEX 1-2 METHODS F		RVATION	337
A1-2.1	INTRODUC	TION	337
A1-2.2	COLLECTIN	G	338
	<i>EX SITU CC</i> A1-2.3.1 A1-2.3.2 A1-2.3.3 A1-2.3.4 A1-2.3.5 A1-2.3.6 A1-2.3.7	GIES AND METHODS FOR NSERVATION Storage of seeds in conventional seed genebanks Maintenance of living plants in field genebanks In vitro storage Pollen storage Ultra-dry seed storage Conservation of DNA or DNA sequences Botanical gardens	339 340 341 342 344 345 346 346
A1-2.4	TYPES OF E	EX SITU COLLECTIONS	347
A1-2.5	A1-2.5.1 A1-2.5.2 A1-2.5.3	ENT OF EX SITU COLLECTIONS Duplication Regeneration of genebank accessions Passport, characterization and evaluation data Germplasm health aspects of <i>ex situ</i> management	<b>348</b> 348 348 349 350
A1-2.6	A1-2.6.1	Protected Areas	<b>351</b> 351 354 359

#### **ANNEX 1-3 METHODS FOR UTILIZATION OF PGRFA** THROUGH PLANT BREEDING

		-
- 3	_	

			007
A1-3.1	INTRODU	CTION	369
A1-3.2	PLANT BRE	EDING: GOAL SETTING	371
A1-3.3	<b>PLANT BRE</b> A1-3.3.2	EDING: GENERATING NEW COMBINATIONS Incorporation	<b>372</b> 377
A1-3.4	<b>PLANT BRE</b> A1-3.4.1 A1-3.4.2	EDING: SELECTION Selection procedures for inbred pure lines Selection procedures for	<b>379</b> 379
	A1-3.4.3 A1-3.4.4	open-pollinated populations Selection procedures for hybrid varieties Selection procedures for clones	380 380 380
A1-3.5	PLANT BRE	EDING: RELEASE AND DISTRIBUTION	382



ANNEX 1-4	
LEGAL AND ECONOMIC METHODS	
RELEVANT TO PGRFA	

INTRODUCTION

<b>RELEVANT T</b>	O PGRFA	393
A1-4.1	METHODS FOR VALUATING PGRFA	393
	POSSIBLE MECHANISMS FOR REALIZING THE VALUE OF GENETIC RESOURCES AND OF RELATED INNOVATIONS A1-4.2.1 Intellectual property rights A1-4.2.2 Contracts	<b>395</b> 395 402
A1-4.3	INTERNATIONAL FUNDING MECHANISMS	405
ANNEX 2 STATE OF DI	VERSITY OF MAJOR AND MINOR CROPS	411

A2.1	INTRODU	CTION	411
A2.2	A2.2.1 A2.2.2 A2.2.3 A2.2.4 A2.2.5 A2.2.6 A2.2.7 A2.2.8 A2.2.9 A2.2.10 A2.2.11	State of sugar cane genetic resources	413 413 415 418 420 422 424 427 429 432 433 436 438 440
A2.3	STATE OF	DIVERSITY OF MINOR CROPS	443
	COUNTR MES AND	RY OF NATIONAL LEGISLATION, D ACTIVITIES FOR PGRFA	455
	AJOR GEF		463
		IIOIE	
ACRO	NYMS		485
APPENDIX REGIONS	-	SITY OF CULTIVATED PLANTS	501

501



### LIST OF BOXES

Box 1.1 Box 1.2	Who are the world's farmers? Examples of the introgression of valuable	25
	agronomic traits from landraces	28
Box 1.3	Examples of introgression of valuable agronomic traits from wild relatives of crops	29
Box 1.4	The economics of genetic resources loss	39
Box 2.1	Indigenous knowledge about Plant Genetic Resources for Food and Agriculture	54
Box 2.2	Factors affecting the capacity of farmers and communities to manage PGRFA	62
Box 2.3	The Community Biodiversity Development and Conservation Programme	65
Box 2.4 Box 2.5	Traditional conservation methods in West Africa PGRFA rehabilitation programmes	68 69
Box 3.1	Genetic erosion in genebanks	113
Box 4.1 Box 4.2 Box 4.3	Core collections The "breeders' diversity triangle" Use of new biotechnology for PGRFA	150 151
Box 4.4	in developing countries Breeding for wide and specific adaptation	155 169
Box 4.5	Some traits and qualities subject to improvement by breeders	184
Box 5.1 Box 5.2 Box 5.3	National PGRFA programmes The Philippines Presidential Executive Order No.247 EU legislation in support of on-farm conservation	199 217 224
Box 6.1 Box 6.2 Box 6.3	Regeneration of Latin American maize through LAMP International co-operation and biotechnology transfer Terms of Reference of the Commission on Genetic Resources for Food and Agriculture	245 247 258
		230
Box 7.1 Box 7.2 Box 7.3 Box 7.4	Access to genetic resources and the fair and equitable sharing of benefits derived from their use: provisions of the Convention on Biological Diversity Farmers' Rights Impact of IPRs on access to PGRFA Sharing the benefits of PGRFA: how much can	277 278 285
Box 7.5	bilateral arrangements deliver? Priority activities of the Global Plan of Action	290 302
Box A1.1 Box A1.2 Box A1.3 Box A1.4 Box A1.5 Box A1.6 Box A1.7 Box A1.8	The International Rice Genealogy Database Relative costs of using molecular markers Species recovery plan 1994 IUCN Revised Protected Area Categories Elements of a management plan for genetic reserves Joint management for conservation UNESCO's Man and the Biosphere Programme F1 hybrids or synthetic and composite populations?	316 321 354 356 357 358 360 381



Box A1.10 Examples of patents issued in the United States	397
Box A1.11 Extract from "standard order form" of	
germplasm from collections of the IARCs	403
Box A1.12 Possible model provisions for MTAs in line with	
the Convention on Biological Diversity	404

### LIST OF TABLES

	Preparatory meetings for the International Technical Conference	5
Table 3.1	Selected crops: The six largest countries', CGIAR centres' and regional genebanks'	
Table 3.2	holdings of <i>ex situ</i> germplasm collections	92
	Percentage of indigenous accessions in national genebanks	96
Table 3.3	Genebanks and accessions in <i>ex situ</i> collections, by region	98
Table 3.4	Ex situ storage facilities and the regeneration	
Table 3.5	situation in the world's largest national base collections <i>Ex situ</i> storage facilities and main crops conserved	99
TILOV	in regional genebanks	106
Table 3.6	<i>Ex situ</i> storage facilities and extent of duplication in CGIAR centres	107
Table 3.7	Characterization of accessions in selected national <i>ex situ</i> collections	123
		123
Table 4.1	Average annual distribution of germplasm inside and outside the CGIAR centres, 1992 to 1994	142
Table 4.2	Obstacles to the greater use of PGRFA	145
Table 4.3	Extent of evaluation of country collections	147
Table 4.4	The world's largest private-sector seed companies	158
Table 5.1	Obstacles to training and how they might be overcome	211
Table 6.1 Table 6.2	Regional and sub-regional PGRFA networks Mandate crops and ecoregional mandate	236
	of selected IARCs	250
Table 6.3	Status of the Global System on the Conservation	
	and Utilization of PGRFA	257
Table 6.4	The International Network of Ex Situ Collections	260
Table 7.1	Percentage of germplasm samples distributed	201
	annually by CGIAR centres, by sector (1992-1994)	281
Table A1.1	Crop species descriptor lists published by IPGRI	317
Table A1.2	Advantages and disadvantages of some currently used methods of measuring genetic variation	318
Table A1.3	Different conservation strategies for different	510
	frequencies of alleles of phenotypes	322
Table A1.4	Some major issues and questions of interest	205
Table A1 5	to genebank curators Some species with recelsitrant coods	325 340
TUDIE AT.3	Some species with recalcitrant seeds	540



Table A1.6	Technologies for ex situ conservation of	
	different types of PGRFA	341
Table A1.7	List of some plant species for which	
	genome mapping projects are under way	373
Table A1.8	Some qualitative and quantitative traits which	
	have been mapped using molecular markers	373
Table A1.9	Some plant resistance genes to pathogens which	
	have been isolated and cloned since 1992	376
Table A1.10	Populations and breeding methods	379
Table A1.11	Comparison of formal-sector and farmer-	
	based plant breeding	383
	Case studies of participatory plant breeding	384
Table A1.13	Options for involvement of farmers and	
	formal-sector breeders	385
Table A2.1	Selection of minor and underutilized crops species	444

### LIST OF FIGURES

Figure 1.1 Figure 1.2	Estimated numbers of food species Most important crops for food energy supply	14 15
Figure 1.3	Main staple food supply in the subregions of the world	17
Figure 1.4	Regions of diversity of major cultivated plants	21
Figure 1.5	Percentages of food production of major crops	
0	based on species originating from other regions	23
Figure 1.6	Causes of genetic erosion mentioned in	
	Country Reports	34
Figure 3.1	Proportions of genebank accessions per type	
	of institution worldwide	84
Figure 3.2	Number of accessions collected by the CGIAR centres	86
Figure 3.3	Contribution of major crop groups to total	
	ex situ collections	90
Figure 3.4	Types of accessions in <i>ex situ</i> collections	94
Figure 3.5	Percentage of <i>ex situ</i> collection by storage type	101
Figure 3.6	Status of national <i>ex situ</i> collections	103
Figure 3.7	Percentage of accessions in national collections	
F: 0.0	remaining to be regenerated	114
Figure 3.8	Regeneration problems reported by countries	115
Figure 3.9	Extent of passport data by region	120
Figure 3.10	Extent of characterization of <i>ex situ</i> collections: selected countries	121
Figure 3.11	Conservation of PGRFA in botanical gardens	127
rigore 5.11	Conservation of PORTA in bolanical gardens	127
Figure 4.1	Public and private plant breeding programmes	157
Figure 4.2	Reported constraints to plant breeding activities	160
Figure 4.3	Public- and private-sector seed systems	173
Figure 4.4	Poor seed distribution systems as a constraint	
	to the distribution of improved varieties	175
Figure 5.1	Status of national programmes	201
Figure 5.2	Global status of plant breeders' rights legislation	221
5		



U U	national programmes, 1986-1991	283
Figure 7.2	Plant breeders' rights awarded from 1989 to 1993	292
Figure A1.1	IUCN threatened species categories	352
Figure A1.2	The breeding cycle	370
Figure A1.3	Complexity and costs of plant biotechnology	
C C	and breeding techniques	372
Figure A2.1	Wheat yields, globally and for selected regions	415
Figure A2.2	Rice yields, globally and for selected regions	417
Figure A2.3	Maize yields, globally and for selected regions	420
Figure A2.4	Sorghum yields, globally and for selected regions	422
Figure A2.5	Millet yields, globally and for selected regions	424
Figure A2.6	Cassava yields, globally and for selected regions	426
Figure A2.7	Potato yields, globally and for selected regions	429
Figure A2.8	Sweet potato yields, globally and for selected regions	s <b>4</b> 31
Figure A2.9	Dry bean yields, globally and for selected regions	435
Figure A2.10	Soybean yields, globally and for selected regions	437
Figure A2.11	Sugar cane yields, globally and for selected regions	440





### **Acknowledgements**

This book could not have been prepared without the help of the many individuals who generously contributed their time, energy and expertise to its research, drafting and production. Listing every person by name is not easy, and carries with it the risk that someone may be overlooked - a high probability in an undertaking of this size. Apologies are conveyed to anyone who may have provided assistance whose name has been inadvertently omitted. It is customary and appropriate to note that any errors or omissions in this work are the responsibility of those who compiled it. None of the contributors should be considered responsible for such defects. In this regard, FAO appreciates any corrections.

Since the primary source of information for *The State of the World's Plant Genetic Resources for Food and Agriculture* was the 154 Country Reports provided by the respective governments, the first acknowledgement and thanks must go to these governments and to all of those individuals in each country who contributed to their respective Country Reports. Representatives of countries and other participants at the 11 subregional and regional preparatory meetings also provided important inputs in the development of this Report. Information was also derived from the Subregional Synthesis Reports which were compiled by Elizabeth Acheampong, Helen Ager, Nestor C. Altoveros, Amadou Beye, Zofia Bulinska Radomska, Eshan Dulloo, Hareya Fassil, Emile Frison, Thomas Gass, Ankon Goli, Gerry Jayawardena, Dan Kiambi, Vincent Lebot, Zhou Mingde, Armando Okada, Stefano Padulosi, Antonio Pinchinat, Kenneth Riley, Jesus Sanchez, José Toledo, Jane Toll, Mohammed Tazi and Jozef Turok.

The State of the World's Plant Genetic Resources for Food and Agriculture was compiled and produced by a team at FAO coordinated by Cary Fowler and David Cooper, consisting of Mona Chaya, Samy Gaiji, Iqbal Kermali, Kristin Kolshus, Martin Maurer, Alison McCusker, Suzanne Sharrock, José de Souza-Silva, Charlie Spillane, Detlef Virchow and Zheng Bo. Major contributions to the report were prepared by Åsmund Bjørnstad, Peter Day, Eshan Dulloo, Esbern Friis Hansen and Michel Pimbert. Valuable inputs and advice were provided by FAO colleagues, notably: Murthi Anishetty, José Esquinas-Alcázar, Umberto Menini, Cadmo Rosell, Jerzy Serwinski, Clive Stannard, Kar-Ling Tao and Mohamed S. Zehni. Editing of the documents was performed by Ann Pulver, Ruth Raymond and Diane Dixon.



Design was created by IKONOS' Luigi Canali De Rossi, the layout was executed by SISIFO staff, and all revisions and final pagination of the book, for both printed and electronic versions, were done by IKONOS' Simone Morini. Design advice and technical support were given by Nicholas Rubery and Andrew Marx of FAO.

Administrative and secretarial support was provided by Angelo Baggiossi, Marie-Rose Burrow, Melanie Howe, Marian Jones-Cammarata, Claudia Fiori, Carla G. Ricciardi and Sonia Zepeda de Natangelo.

Many other FAO staff also provided contributions, including: Jacques Antoine, Enrique Arias, Sally Bunning, A. Condos, Nour-Eddine Gaddes, Cyril Groom, Guido Gryseels, Hartwig de Haen, Patrick Heffer, Catherine Hill, Juan Izquierdo, Peter Kenmore, Eric Kueneman, Mirek Maluszynski, Andreas Papasolomontos, Tonie Putter, Denis Sims, Dat Van Tran, Victor Villalobos and Ed Weck.

Various staff members of IPGRI and the other CGIAR Centres also provided invaluable assistance through inputs and review of draft material, notably: Jacqueline Ashby, Sara Ashmore, George Ayad, Margarita Baena, R. Best, Merideth Bonierbale, Tim Boyle, Salvatore Ceccarelli, Ram C. Chaudhary, José Crossa, Gregory O. Edmeades, Jan Engels, Pablo Eyzaguirre, Marlene Diekmann, Paul Fox, Emile Frison, Thomas Gass, Ali Golmirzaie, Luigi Guarino, Claudia Guevara, Jean Hanson, Geoffrey Hawtin, Toby Hodgkin, David Hoisington, Miguel Holle, Zosimo Huaman, Masa Iwanaga, Mike T. Jackson, John Komen, Julia Kornegay, G.S. Khush, Jill Lenné, Quat Ng, Stefano Padulosi, Phil Pardey, Mark Perry, Ramanatha Rao, William M. Roca, Roger Rowe, Rosina Salerno, Surapong Sarkarung, Yves Savidan, William R. Scowcroft, J. Antonio Serratos, Bent Skovmand, Melinda Smale, Paul Stapleton, John Stenhouse, Suketoshi Taba, Jane Toll, Ann Marie Thro, Sant Virmani, Eva Weltzien and Maria Zimmermann.

Many other expert individuals with particular expertise in relevant areas provided valuable written inputs, comments and review. Special thanks go to those who reviewed the document: Carlos Correa, Elizabeth Cromwell, Pamela Fernandez, Jorgé León, Gordon Mkamanga, Enrique Sánchez Monge, Henry Shands, Stephen Smith, Timothy Swanson and Melaku Worede, as well as staff of IPGRI. Among the many other contributors were: Nelson Alvarez, Rudi Appels, Gerardo Arias, Dave Astley, V. Balaji, David D. Baltensperger, Steve Beebe, Geraldo U. Berger, Erik Bernard, Julien Berthaud, Robert Bird, Richard Blyton, Mark Bohning, Howarth Bouis, Dan Bradley, Rex Brennan, David Brenner, James Brewbaker, Anthony H.D. Brown, Steve Brush, Jeremy J. Burdon, William Burnquist, Thomas



Carter, Brett F. Carver, Helen Case, Francisco Chapela, Phil Clarke, Mike Collinson, Robert J. Cooke, Peter Crawford, Phil Dale, Daniel Debouck, Allan Deutsch, Donald N. Duvick, Richard Ellis, Robert E. Evenson, Claude Fauquet, Pamela G. Fernandez, Nic Flanagan, Dick Flavell, Brian Ford-Lloyd, Douglas Forno, Paul Fox, Madhav Gadgil, Mike D. Gale, Paul Gepts, Harriet Gillett, Harris Gleckman, Lyle Glowka, Doug Gollin, Anil K. Gupta, Richard E. Harrison, Jeremy Hayter, Nazmul Haq, Patrick M. Hayes, D. Hides, Fiona Hinchcliffe, Henk Hobbelink, Corley Holbrook, Gilbert Howe, Roger Hull, Roger Hyam, Theodore Hymowitz, Kamal Ibrahim, James E. Irvine, Bob Jarrett, Richard Johnson, Angela Karp, Andre de Kathen, Wilma Kebebe, Maarten Koornneef, Ashish Kothari, Stephen Kresovich, Claire Lanaud, Warren Lamboy, Brian Larkins, Viv Lewis, David Luckett, David F. Marshall, Ana-Rosa Martinez i Prat, Dave Matthews, N. Maxted, Jim McFerson, Jerome Miksche, Najeeb Mirza, Patrick Mulvany, Neil Nel, Randall Nelson, Angela Pasceri, Andrew Paterson, Robin Pistorius, C.S. Prakash, John Prendergast, Mark Prendergast, Calvin Qualset, David Rae, Shirish Ranade, Dwijen Rangnekar, James Reeves, Ana Rivero, Jane Robertson, Eric Roos, Ruaraidh Sackville-Hamilton, G. Sage, Wilfredo Salhuana, Brendan J. Scott, Al Schneiter, Jim Siedow, Albert Smith, Daniela Soleri, John Soper, Louise Sperling, David Spooner, Wendy Strahm, Anukriti Sud, R.J. Summerfield, Helen Thompson, Doug Tiffany, Mike Trimble, Robert Tripp, George T. Tzotzos, A.M. van Dommelen, Renée Vellvé, Ronnie Vernooy, Ben Vosman, Joachim Voss, Christina Walters, Mark Widrlechner, John R. Witcombe, Daniel Wong, Peter S. Wyse Jackson, Brian Wright, Andrew Young and Francis Zee.





## acronyms and abbreviations<sup>1</sup>

ACIAR	Australian Council for International Agricultural Research
ACSAD	Arab Centre for the Studies of Arid Zones and Dry Lands
ACTS	African Centre for Technology Studies
AFLP	amplified fragment length polymorphism
AFNETA	Alley Farming Network for Tropical Africa
AFRENA	Agroforestry Research Network for the Highlands of East and Central Africa
AMCEN	African Ministerial Conference on Environment
ANZNPGRC	Australian and New Zealand Network of Plant Genetic Resource Centres
APSA	Asia Pacific Seed Association
ASARECA	Association of Agricultural Research in East and Central Africa
ASEAN	Association of Southeast-Asian Nations
ASEAN-PLANTI	Asian Plant Quarantine Centre and Training Institute
AS-PTA	Assesoria e Servicos à Projetos em Agricultura Alternativa (NGO, Brazil)
AVRDC	Asian Vegetable Research and Development Centre
BGCI	International Association of Botanic Gardens
BMZ	German Ministry for Economic Cooperation and Development
BRAHAMS	Botanical Research and Herbarium Management Systems
CAA	Community Aid Abroad (Australia)
CAPGRIS	Canadian Agricultural Plant Genetic Resources Information System
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CATIE	Tropical Agricultural Research and Training Centre
CBD	Convention on Biological Diversity



CBDC	Community Biodiversity Development and Conservation Programme
CENARGEN	Centro Nacional de Recursos Geneticos (Brazil)
CET	Centro de Educación y Tecnología (NGO, Chile)
CGIAR	Consultative Group on International Agricultural Research
CGN	Centre for Genetic Resources of the Netherlands
CIAT	International Centre for Tropical Agriculture (CGIAR)
CICD	Centro de Investigación y Capacitación para el Desarollo (NGO, Peru)
CIDA	Canadian International Development Agency
CIFOR	Centre for International Forestry Research (CGIAR)
СІММҮТ	Centro Internacional de Mejoramiento de Maíz y Trigo International Centre for Maize and Wheat Improvement (CGIAR)
CIP	International Potato Centre (CGIAR)
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France)
CLADES	Latin American Consortium on Agro-ecology and Development
CNR	National Research Council of Italy
COGENT	Coconut Genetic Resources Network
COMECON	Council for Mutual Economic Assistance
COMMUTEC	Community Technology Development Association (NGO, Zimbabwe)
CONSERVE	Community-based Native Seed Research Centre (NGO, the Philippines)
CoP/CBD	Conference of the Parties of the Convention on Biological Diversity
CORAF	Conference of Directors of Agronomic Research in West and Central Africa
CPGR	FAO Commission on Plant Genetic Resources
CSC	Commonwealth Science Council
CSEGRIN	Caribbean Seed and Germplasm Resources Information Network



CTA	Technical Centre for Agricultural and Rural Cooperation
DNA	desoxyribonucleic acid
DUS	distinct, uniform and stable
EARCORBE	East African Regional Cooperative for Research on Banana and Enset
EARRNET	East African Root Crops Research Network
EARSMN	Eastern Africa Research on Sorghum and Millet Network
ECP/GR	European Cooperative Programme on Crop Genetic Resources Networks
EEC	European Economic Community
ESCORENA	European System of Cooperative Research Networks in Agriculture
EU	European Union
EUFORGEN	European Forest Genetic Resources Network
FAO	Food and Agriculture Organization of the United Nations
GATT	General Agreement on Tariffs and Trade
GBS	Global Biodiversity Strategy (IUCN/UNEP/WWF)
GDP	gross domestic product
GEF	Global Environment Facility (World Bank/UNEP/UNDP)
GEM	Germplasm Enhancement Maize Project (United States)
GEPA	Aktion Dritte Welt Handel (NGO, Germany)
GIS	Geographic Information System
GRAIN	Genetic Resources Action International (NGO, Spain)
GRIN	Germplasm Resources Information Network (United States)
GRUs	genetic resource units
GTZ	German Agency for Technical Cooperation
HYV	high-yielding variety
IABG	International Association of Botanic Gardens
IACNET	Inter-american Citrus Network
IADB	Inter-american Development Bank
IARCs	International Agricultural Research Centres



IBPGR	International Board for Plant Genetic Resources (CGIAR, now IPGRI)
IBS	Intermediary Biotechnology Service
ICARDA	International Centre for Agricultural Research in the Dry Areas (CGIAR )
ICRAF	International Center for Research in Agroforestry (CGIAR )
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICSU	International Council of Scientific Unions
ICUC	International Centre for Underutilized Crops
ICWG-GR	Inter-Centre Working Group on Genetic Resources (CGIAR)
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute (CGIAR)
IGADD	Inter-governmental Authority on Drought and Development
IICA	Inter-American Institute for Cooperation on Agriculture
IIED	International Institute for Environment and Development
IITA	International Institute of Tropical Agriculture (CGIAR)
ILO	International Labour Organisation
ILRI	International Livestock Research Institute (CGIAR)
IMC	Instituto Mayor Campesino (NGO, Colombia)
IMF	International Monetary Fund
INBAR	International Network for Bamboo and Rattan
INGER	International Network for the Genetic Evaluation of Rice
INIBAP	International Network for the Improvement of Bananas and Plantains
IPGRI	International Plant Genetic Resources Institute (CGIAR, formerly IBPGR)



IPK	Institut für Pflanzengenetik und Kulturpflanzenforschung (Germany)
IPPC	International Plant Protection Convention
IPR	intellectual property rights
IRGDB	International Rice Genealogy Database
IRRI	International Rice Research Institute (CGIAR)
ISAAA	International Service for the Acquisition of Agri-biotech Applications
ISNAR	International Service for National Agricultural Research (CGIAR)
ISSC	International Species Survival Commission
ITCPGR	International Technical Conference on Plant Gentic Resources (1996) (FAO)
IUBS	International Union of Biological Sciences
IUCN	World Conservation Union
LAMP	Latin American Maize Project
МАВ	Man and the Biosphere Programme (UNESCO)
MARDI	Malaysian Agricultural Research and Development Institute
MASIPAG	Farmer-Scientist Partnership for Development Association (the Philippines)
MESFIN	Mediterranean Fruit Inter-country Network
MTA	material transfer agreement
NAA	Non-Agriculture Association (NGO, Thailand)
NARS	National Agricultural Research Systems
NBPGR	National Bureau of Plant Genetic Resources (India)
NGB	Nordic Gene Bank
NGO	non-governmental organization
NPGRC	National Plant Genetic Resources Centres
NPGRL	National Plant Genetics Resources Laboratory (the Philippines)
NPGS	National Plant Germplasm System (United States)
NIAR	National Institute of Agrobiological Resources, Japan



NSSL	National Seed Storage Laboratory (USDA-ARS)
NTAE	non-traditional agricultural export
ODI	Overseas Development Institute (United Kingdom)
OECD	Organisation for Economic Co-operation and Development
OECS	Organization of Eastern Caribbean States
OPV	open-pollinated varieties
ORSTOM	Institut français de recherche scientifique pour le développement en coopération
PBR	plant breeders' rights
PCR	polymerase chain reaction
PGRFA	plant genetic resources for food and agriculture
PRAPACE	Potato and Sweet Potato Improvement Network for Central and Eastern Africa
PROCISUR	Programa Cooperativo para el Desarrollo Tecnológico Agropecuario del Cono Sur
PROSEA	Plant Resources of South East Asia
PVP	plant variety protection
QTL	quantitative trait loci
RAFI	Rural Advancement Foundation International
RAPD	random amplified polymorphic DNA
RBG	Royal Botanic Gardens (Kew, United Kingdom)
RDA	Rural Development Administration (Republic of Korea)
RECSEA	Regional Committee for Southeast Asia
RECSEA-PGR	Regional Collaboration in Southeast Asia on Plant Genetic Resources
REDARFIT	Andean Network of Plant Genetic Resources
REDBIO	Technical Cooperation Network on Plant Biotechnology
REMERFI	Central American Network of Plant Genetic Resources
RESAPAC	Great Lakes Regional Bean Programme
RFLP	restriction fragment length polymorphism
ROCAFREMI	Reseau ouest et central africain de recherche sur le Mil



ROCARS	Reseau ouest et central africain de recherche sur le Sorgho
RS	Recurrent selection
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SADC	Southern African Development Community
SAPPRAD	Southeast Asian Programme for Potato Research and Development
SCOPE	Scientific Committee on Problems of the Environment
SEANUC	Southern and Eastern African Network on Under-utilized Crops
SEARICE	South East Asian Institute for Community Education (NGO, the Philippines)
SELA	Sistema económico latinoamericano
SGRP	System-wide Genetic Resources Programme (of CGIAR)
SIDA	Swedish International Development Authority
SINGER	System-wide Information Network on Genetic Resources
SPC	South Pacific Commission
SPGR	System-wide Programme on Genetic Resources
SPGRC	SADC Plant Genetic Resources Centre
SPREP	South Pacific Regional Environment Programme
TREE	Technology for Rural and Ecological Enrichment (NGO, Thailand)
TRIPs	trade-related aspects of intellectual property rights
TROPIGEN	Amazonian Network of Plant Genetic Resources
UFTANET	Under-utilized Tropical Fruit Trees Network
UK	United Kingdom
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization



UNIDO	United Nations Industrial Development Organization
UPOV	International Union for the Protection of New Varieties of Plants
UPWARD	User's Perspective with Agricultural Research and Development
USA	United States of America
USDA/ARS	United States Department of Agriculture/ Agricultural Research Service
USSR	Union of Soviet Socialist Republics
VIR N.I.	Vavilov Institute (Russian Federation)
WANANET	West Asia and North Africa Plant Genetic Resources Network
WARDA	West Africa Rice Development Association
WIEWS	FAO World Information and Early Warning System on Plant Genetic Resources
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
WRI	World Resources Institute
WTO	World Trade Organization
WWF	World Wide Fund for Nature

<sup>&</sup>lt;sup>1</sup> Additional acronyms of institutions referred to in Annex 2 and Appendix 2 are presented in Appendix 2.



## THE FIRST SECTION OF THIS BOOK IS OVER.

## PLEASE CLICK ANYWHERE IN THIS PAGE TO GO TO THE CHAPTERS.