



THE STATE OF THE WORLD's

ANIMAL GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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 of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by the Food and Agriculture Organization of the United Nations in preference to others of a similar nature that are not mentioned.

ISBN 978-92-5-105762-9

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
Electronic Publishing Policy and Support Branch
Communication Division
FAO
Viale delle Terme di Caracalla, 00153 Rome, Italy or by e-mail to:
copyright@fao.org
© FAO 2007

Citation: FAO. 2007. The State of the World's Animal Genetic Resources for Food and Agriculture, edited by Barbara Rischkowsky & Dafydd Pilling. Rome.

Foreword

he wise management of the world's agricultural biodiversity is becoming an ever greater challenge for the international community. The livestock sector in particular is undergoing dramatic changes as large-scale production expands in response to surging demand for meat, milk and eggs. A wide portfolio of animal genetic resources is crucial to adapting and developing our agricultural production systems. Climate change and the emergence of new and virulent animal diseases underline the need to retain this adaptive capacity. For hundreds of millions of poor rural households, livestock remain a key asset, often meeting multiple needs, and enabling livelihoods to be built in some of the world's harshest environments. Livestock production makes a vital contribution to food and livelihood security, and to meeting the United Nations Millennium Development Goals. It will be of increasing significance in the coming decades.

And yet, genetic diversity is under threat. The reported rate of breed extinctions is of great concern, but it is even more worrying that unrecorded genetic resources are being lost before their characteristics can be studied and their potential evaluated. Strenuous efforts to understand, prioritize and protect the world's animal genetic resources for food and agriculture are required. Sustainable patterns of utilization must be established. Traditional livestock keepers – often poor and in marginal environments – have been the stewards of much of our animal genetic diversity. We should not ignore their role or neglect their needs. Equitable arrangements for benefit-sharing are needed, and broad access to genetic resources must be ensured. An agreed international framework for the management of these resources is crucial.

This report is the first global assessment of the status and trends of animal genetic resources, and of the state of institutional and technological capacity to manage these resources. It provides a basis for renewed efforts to ensure that the commitments to the improved management of genetic resources set out in the World Food Summit Plan of Action are realized. It is a milestone in the work of the Commission on Genetic Resources for Food and Agriculture. The support provided by the world's governments, exemplified by the 169 Country Reports submitted to FAO, has been particularly heartening. I am also greatly encouraged by the contribution that the process of preparing this report has already made to awareness of the topic and to catalysing activity at national and regional levels. However, much remains to be done. The launch of The State of the World's Animal Genetic Resources for Food and Agriculture at the International Technical Conference on Animal Genetic Resources at Interlaken, Switzerland, must be a springboard for action. I wish to take this opportunity to appeal to the international community to recognize that animal genetic resources are a part of our common heritage that is too valuable to neglect. Commitment and cooperation in the sustainable use, development and conservation of these resources are urgently required.

Jacques Diouf
FAO Director-General

Contents

Acknowledgements	xxi
Preface	xxv
The reporting and preparatory process	xxvii
Executive summary	XXXV

art 1 The state of agricultural biodiversity in the livestock sector

Introduction			
SECTION A:	ORIGIN AND HISTORY OF LIVESTOCK DIVERSITY		
	1 Introduction	5	
	2 The livestock domestication process	6	
	3 Ancestors and geographic origins of our livestock	10	
	4 Dispersal of domesticated animals	14	
	5 Transformations in livestock following domestication	17	
	6 Conclusions	18	
	References	19	
SECTION B:	STATUS OF ANIMAL GENETIC RESOURCES	23	
	1 Introduction	23	
	2 State of reporting	23	
	3 Species diversity	27	
	3.1 The big five	28	
	3.2 Other widespread species	29	
	3.3 Species with a narrower distribution	30	
	4 Breed diversity	31	
	4.1 Overview	31	
	4.2 Local breeds	34	
	4.3 Regional transboundary breeds	35	
	4.4 International transboundary breeds	36	
	5 Risk status of animal genetic resources	37	
	6 Trends in breed status	44	
	6.1 Changes in the number of breeds in the different breed groups	44	
	6.2 Trends in genetic erosion	45	
	7 Conclusions	48	
SECTION C:	FLOWS OF ANIMAL GENETIC RESOURCES	51	
	1 Introduction	51	
	2 Driving forces and historical phases in gene flows	51	
	2.1 Phase 1: prehistory to the eighteenth century	52	
	2.2 Phase 2: nineteenth to mid-twentieth centuries	53	
	2.3 Phase 3: mid-twentieth century to the present	53	

SECTION C:	FLOWS OF ANIMAL GENETIC RESOURCES - continued	
	3.1 Cattle 3.2 Sheep 3.3 Goats 3.4 Pigs 3.5 Chickens 3.6 Other species 4 Impacts of gene flows on diversity 4.1 Diversity-enhancing gene flow 4.2 Diversity-reducing gene flow 4.3 Diversity-neutral gene flow 4.4 The future References	55 56 61 65 67 69 70 71 71 72 72 73
SECTION D:	USES AND VALUES OF ANIMAL GENETIC RESOURCES	77
	1 Introduction	77
	2 Contribution to national economies	77
	3 Patterns of livestock distribution	80
	4 Food production	84
	5 Production of fibre, skins, hides and pelts	86
	6 Agricultural inputs, transport and fuel	88
	7 Other uses and values	90
	7.1 Savings and risk management	90
	7.2 Sociocultural roles	92
	7.3 Environmental services	95
	8 Roles of livestock for the poor	97
	9 Conclusions	99
	References	100
SECTION E:	ANIMAL GENETIC RESOURCES AND RESISTANCE TO DISEAS	E101
	1 Introduction	101
	2 Disease resistant or tolerant breeds	103
	2.1 Trypanosomiasis	104
	2.2 Ticks and tick-borne diseases	104
	2.3 Internal parasites	104
	2.4 Foot rot	106
	2.5 Bovine leukosis	107
	2.6 Diseases of poultry	107
	3 Opportunities for within-breed selection for disease resistance	108
	4 Conclusions	110
	References	110

		 1 Introduction 2 Livestock sector trends: economic, social and policy factors 3 Disasters and emergencies 4 Epidemics and disease control measures 5 Conclusions References 	113 114 120 126 131 132
Part 2	Livestock s	sector trends	
	Introduction SECTION A:	DRIVERS OF CHANGE IN THE LIVESTOCK SECTOR	141
		1 Changes in demand	141
		1.1 Purchasing power	143
		1.2 Urbanization	143
		1.3 Consumer taste and preference	145
		2 Trade and retailing	145
		2.1 Flows of livestock and their products	145
		2.2 The rise of large retailers and vertical coordination along	
		the food chain	147
		3 Changing natural environment	149
		4 Advances in technology	149
		5 Policy environment	150
	SECTION B:	LIVESTOCK SECTOR'S RESPONSE	153
		1 Landless industrialized production systems	155
		1.1 Overview and trends	155
		1.2 Environmental issues	161
		2 Small-scale landless systems	163
		2.1 Overview	163
		2.2 Environmental issues	164
		2.3 Trends	164
		3 Grassland-based systems	165
		3.1 Overview	165
		3.2 Environmental issues	166
		3.3 Trends	168
		4 Mixed farming systems	170
		4.1 Overview	170
		4.2 Environmental issues	172
		4.3 Trends	173
		5 Issues in mixed irrigated systems	174

SECTION F: THREATS TO LIVESTOCK GENETIC DIVERSITY

113

Introduction	INSTITUTIONS AND STAVELIOLDERS	10
SECTION A:	INSTITUTIONS AND STAKEHOLDERS	187
	1 Introduction	187 187
	2 Analytical framework2.1 Stakeholders' involvement and background at country level	188
	2.2 Assessment of institutional capacities at country level	188
	2.3 Organizations and networks with a potential role in regional	100
	and international collaboration	190
	3 Stakeholders, institutions, capacities and structures	190
	3.1 Stakeholder involvement in the State of the World process	
	at country level	190
	3.2 Assessment of institutional capacities at country and	
	regional level	191
	3.3 Organizations and networks with a potential role in	
	subregional, regional and international collaboration	196
	4 Conclusions	201
	References	203
	Annex	204
SECTION B:	STRUCTURED BREEDING PROGRAMMES	21
	1 Introduction	215
	2 Species priorities and breeding objectives	216
	2.1 Cattle	216
	2.2 Buffaloes	217
	2.3 Sheep and goats	218 219
	2.4 Pigs2.5 Poultry	219
	2.6 Other species	219
	3 Organizational structures	220
	4 Tools and implementation	222
	5 Overview of breeding programmes by region	225
	5.1 Africa	225
	5.2 Asia	227
	5.3 Europe and the Caucasus	229
	5.4 Latin America and the Caribbean	230
	5.5 Near and Middle East	232
	515 11cd. d.1d.1111dd.1c 2d5t	
	5.6 North America and Southwest Pacific	232
		232 23 3
	5.6 North America and Southwest Pacific	

IMPLICATIONS OF THE CHANGES IN THE LIVESTOCK SECTOR

177

179

FOR GENETIC DIVERSITY

References

SECTION C:

SECTION C:	CONSERVATION PROGRAMMES	243
	1 Introduction	243
	2 Global status	244
	3 Stakeholders	245
	3.1 National governments	245
	3.2 Universities and research institutes	246
	3.3 Civil society organizations and breeders' associations	246
	3.4 Farmers	246
	3.5 Part-time or hobby farmers	247
	3.6 Breeding companies	247
	4 Conservation at species level – status and opportunities	247
	4.1 Cattle	247
	4.2 Sheep 4.3 Goats	248 249
	4.5 Gods 4.4 Pigs	249
	4.5 Chickens	249
	4.6 Horses	250
	5 <i>In vivo</i> and <i>in vitro</i> conservation programmes – regional analysis	
	5.1 Africa	250
	5.2 Asia	253
	5.3 Europe and the Caucasus	255
	5.4 Latin America and the Caribbean	256
	5.5 Near and Middle East	258
	5.6 North America	258
	5.7 Southwest Pacific	259
	6 Opportunities for improving conservation programmes	260
	7 Conclusions and priorities	261
	References	263
SECTION D:	REPRODUCTIVE AND MOLECULAR BIOTECHNOLOGY	265
	1 Introduction	265
	2 Global overview	265
	3 Africa	266
	4 Asia	268
	5 Europe and the Caucasus	269
	6 Latin America and the Caribbean	271
	7 Near and Middle East	272
	8 North America	272
	9 Southwest Pacific	272
	10 Conclusions References	273 273
	NC ICICCO	~1 3

		1 International legal framework – major instruments	275
		1.1 Introduction	275
		1.2 Legal framework for the management of biodiversity	275
		1.3 Access and benefit-sharing	277
		1.4 Legal framework for international trade	278
		1.5 Intellectual property rights	279
		1.6 Legal framework for biosecurity	280
		1.7 Conclusions	283
		References	284
		2 Emerging legal issues	285
		2.1 Patenting	285
		2.2 Livestock Keepers' Rights	291
		3 Regulatory frameworks at regional level	291
		3.1 Introduction	291
		3.2 European Union legislation: an example of	
		a comprehensive regional legal framework	292
		3.3 Conclusions	301
		Legislation cited	302
		4 National legislation and policy	307
		4.1 Introduction	307
		4.2 Methods	307
		4.3 Implementation of AnGR-related legislation and programmes	308
		4.4 Country Report analysis	309
		4.5 Conclusions	332
		References	333
Dout 4	C4-4£ 4 -		
Part 4	State of th	e art in the management of animal genetic resou	ırces
	Introduction		
	SECTION A:	BASIC CONCEPTS	
			339
			339
		1 Animal genetic resources and breeds	339
		1 Animal genetic resources and breeds2 Management of animal genetic resources	339 340
		1 Animal genetic resources and breeds	339
		 Animal genetic resources and breeds Management of animal genetic resources Risk status classification 	339 340 342
	SECTION B:	 Animal genetic resources and breeds Management of animal genetic resources Risk status classification 	339 340 342
	SECTION B:	 1 Animal genetic resources and breeds 2 Management of animal genetic resources 3 Risk status classification References 	339 340 342 345
	SECTION B:	 Animal genetic resources and breeds Management of animal genetic resources Risk status classification References METHODS FOR CHARACTERIZATION	339 340 342 345
	SECTION B:	 Animal genetic resources and breeds Management of animal genetic resources Risk status classification References METHODS FOR CHARACTERIZATION Introduction 	339 340 342 345 347
	SECTION B:	 Animal genetic resources and breeds Management of animal genetic resources Risk status classification References METHODS FOR CHARACTERIZATION Introduction Characterization – as the basis for decision-making 	339 340 342 345 347 347 347 350
	SECTION B:	 1 Animal genetic resources and breeds 2 Management of animal genetic resources 3 Risk status classification References METHODS FOR CHARACTERIZATION 1 Introduction 2 Characterization – as the basis for decision-making 3 Tools for characterization 	339 340 342 345 347 347 350 350
	SECTION B:	 1 Animal genetic resources and breeds 2 Management of animal genetic resources 3 Risk status classification References METHODS FOR CHARACTERIZATION 1 Introduction 2 Characterization – as the basis for decision-making 3 Tools for characterization 3.1 Surveying 3.2 Monitoring 	339 340 342 345 347 347 350 350 352
	SECTION B:	 Animal genetic resources and breeds Management of animal genetic resources Risk status classification References METHODS FOR CHARACTERIZATION Introduction Characterization – as the basis for decision-making Tools for characterization 3.1 Surveying 	339 340 342 345 347 347
	SECTION B:	 Animal genetic resources and breeds Management of animal genetic resources Risk status classification References METHODS FOR CHARACTERIZATION Introduction Characterization – as the basis for decision-making Tools for characterization 3.1 Surveying 3.2 Monitoring 3.3 Molecular genetic characterization 	339 340 342 345 347 347 350 350 352 354

SECTION E: LEGISLATION AND REGULATION

275

SECTION C:		DLECULAR MARKERS – A TOOL FOR EXPLORING NETIC DIVERSITY	359
	1	Introduction	359
	2	The roles of molecular technologies in characterization	361
	3	Overview of molecular techniques	362
		3.1 Techniques using DNA markers to assess genetic diversity	362
		3.2 Using markers to estimate effective population size	367
		3.3 Molecular tools for targeting functional variation	367
	4	The role of bioinformatics	372
	5	Conclusions	372
	Ref	erences	375
SECTION D:		NETIC IMPROVEMENT METHODS TO SUPPORT	204
		STAINABLE UTILIZATION	381
		Introduction	381
		The context for genetic improvement	381
		2.1 Changing demand	381
		2.2 Diverse production environments	382
		2.3 Increasing recognition of the importance of genetic diversity	382
		2.4 Scientific and technological advances	382
		2.5 Economic considerations	387
		Elements of a breeding programme	388
		3.1 Breeding goals	390
		3.2 Selection criteria	391
		3.3 Design of breeding scheme	392
		3.4 Data recording and management	392
		3.5 Genetic evaluation	393
		3.6 Selection and mating	394
		3.7 Progress monitoring	395
		3.8 Dissemination of genetic progress	395
		Breeding programmes in high-input systems	396
		4.1 Dairy and beef cattle breeding	396
		4.2 Sheep and goat breeding	400
		4.3 Pig and poultry breeding	402
		Breeding programmes in low-input systems	405
		5.1 Description of low-input systems	405
		5.2 Breeding strategies	406
		Breeding in the context of conservation	420
		6.1 Methods for monitoring small populations	420
		6.2 Conservation through breeding Conclusions	421
			421 423
	Ket	erences	423

SECTION E:	METHODS FOR ECONOMIC VALUATION	429
	1 Introduction	429
	2 Development of methodologies for economic analysis	431
	3 Application of economic methodologies in animal genetic	
	resources management	433
	3.1 Value of animal genetic resources to farmers	433
	3.2 Costs and benefits of conservation	434
	3.3 Targeting of farmers for participation in <i>in situ</i> breed	426
	conservation programmes	436
	3.4 Priority setting in livestock conservation programmes	437
	3.5 Priority setting in livestock breeding strategies	438
	3.6 General policy analysis4 Implications for policies and future research	438 43 9
	References	440
	References	440
SECTION F:	METHODS FOR CONSERVATION	443
	1 Introduction	443
	2 Arguments for conservation	444
	2.1 Arguments related to the past	445
	2.2 Safeguarding for future needs	445
	2.3 Arguments related to the present situation	447
	3 The unit of conservation	448
	4 Conservation of plant versus animal genetic resources	449
	5 Information for conservation decisions	450
	6 In vivo conservation	454
	6.1 Background	454
	6.2 Genetic management of populations	454
	6.3 Self-sustaining strategies for local breeds	455
	6.4 <i>In situ</i> versus ex situ approaches to in vivo conservation	460
	7 Current status and future prospects for cryoconservation	461
	7.1 Gametes	462
	7.2 Embryos	463
	7.3 Cryoconservation of somatic cells and somatic cell cloning	463
	7.4 Choice of genetic material	465
	7.5 Security in genebanks	465
	8 Resource allocation strategies in conservation	466
	8.1 Methods for setting priorities	466
	8.2 Optimization strategies for planning conservation programmes	467
	9 Conclusions	470
	References	473

	SECTION G:	RESEARCH PRIORITIES	477
		1 Information for effective utilization and conservation	477
		2 Information systems	477
		3 Molecular methods	478
		4 Characterization	478
		5 Genetic improvement methods	478
		6 Conservation methods	479
		7 Decision-support tools for conservation	480
		8 Economic analysis	480
		9 Access and benefit-sharing	481
Part 5	Needs and	challenges in animal genetic resources manageme	ent
	Introduction SECTION A:	KNOWLEDGE OF ANIMAL GENETIC DIVERSITY: CONCEPTS, METHODS AND TECHNOLOGIES	487
	SECTION B:	CAPACITY IN ANIMAL GENETIC RESOURCES MANAGEMENT	493
		1 Capacity in characterization, sustainable use and conservation of animal genetic resources	493
		2 Capacity in institutions and policy-making	494
	SECTION C:	MAJOR CHALLENGES FOR LIVESTOCK DEVELOPMENT AND ANIMAL GENETIC RESOURCES MANAGEMENT	499
	SECTION D:	ACCEPTING GLOBAL RESPONSIBILITY	503
Abbreviati	ons and acron	yms	505

Annexes (on CD-ROM)

Country Reports

Reports from International Organizations

Subregional Reports

Thematic Studies

List of breeds documented in the Global Databank for Animal Genetic

Resources

List of breeds at risk

List of authors, reviewers and their affiliations

BOXES

1	The domestication process	6
2	Molecular characterization – a tool to understand livestock origin and diversity	ç
3	The history of African pastoralism	15
4	What is new compared to the World Watch List for Domestic Animal Diversity?	24
5	Glossary: populations, breeds, regions	25
6	Glossary: risk status classification	37
7	Gene flows resulting from colonization	53
8	Nelore cattle	60
9	Continuous repackaging of genes – Dorper sheep	64
10	Hybrid pigs	67
11	The chicken breeding industry	70
12	Linguistic links between cattle and wealth	91
13	The history of Hungarian Grey cattle – changing uses over time	96
14	Genetic resistance to African swine fever	109
15	Mongolian reindeer under threat	116
16	Policy distortions influencing the erosion of pig genetic resources in Viet Nam	118
17	Which dairy breeds for tropical smallholders?	119
18	War and rehabilitation in Bosnia and Herzegovina	126
19	The concept of productivity	140
20	Sustainable utilization of the Iberian pig in Spain – a success story	144
21	Overcoming constraints to the development of small-scale market-oriented	
	dairying	146
22	Facts and trends in the emerging world food economy	151
23	Suggestions for strengthening national structures	202
24	Research and breed development in Africa	226
25	Sheep breeding in Tunisia	226
26	Buffalo breeding in India	227
27	Goat breeding in the Republic of Korea	228
28	Duck breeding in Viet Nam	228
29	Pig breeding in Hungary	230
30	Horse breeding – tradition and new requirements	230
31	Beef cattle breeding in Brazil	23′
32	Breeding Ilamas in Argentina	232
33	Influence of market forces on livestock breeding in the United States of America	233
34	Sheep breeding in Australia	233
35	Mali – role of the government	246
36	Ethiopia – in situ conservation	251
37	Morocco's Plan Moutonnier – designated breeding areas to sustain	
20	local sheep breeds	252
38	Conservation strategies in China	254
39	Denmark – opportunities for <i>in vivo</i> conservation	256
40	Brazil – implementation of a genebank	258
41	United States of America – priorities in conservation programmes	259

43	Impact of international zoosanitary regulations on animal genetic resources	
	management – the example of FMD	282
44	The first patented animal	286
45	The African Union Model Law	292
46	Malawi's Environmental Management Act	308
47	Turkey's Law on Pastures No. 4342 (1998)	310
48	Slovenia's Livestock Breeding Act (2002)	311
49	Mozambique's Livestock Development Policy and Strategies	312
50	Slovenia's regulation on Conservation of Farm Animal Genetic Resources	314
51	Uganda's National Animal Genetic Resources Progamme	315
52	Ukraine's Law on Animal Breeding	316
53	Turkey's Regulation on Protection of Animal Genetic Resources (2002)	316
54	Lesotho's Importation and Exportation of Livestock and	
	Livestock Products Proclamation	318
55	Malaysia's Animals Ordinance	318
56	Hungary's Decree No. 39	319
57	Botswana's Stock Diseases (Semen) Regulations	320
58	Barbados's incentive programme	320
59	Uganda's Animal Breeding Act (2001)	322
60	Guatemala – decentralization of the registration of pure-bred animals	323
61	Mongolia's White Revolution Programme	324
62	The Philippine's White Revolution	325
63	Russian Federation – Veterinary and Sanitary Requirements	
	No. 13-8-01/1-8 (1999)	327
64	India – rules for transportation	328
65	West Africa – pastoralists crossing borders	328
66	The Islamic Republic of Iran's Act of National Veterinary System (1971)	330
67	Definition of breed adopted by FAO	339
68	Production environment descriptors for animal genetic resources	350
69	Information systems at global level	356
70	DNA, RNA and protein	359
71	The new "-omics" scientific disciplines	360
72	Recent developments in molecular biology	360
73	Extraction and multiplication of DNA and RNA	362
74	Commonly used DNA markers	363
75	Sampling genetic material	364
76	QTL mapping	367
77	The population genomics approach	369
78	Databases of biological molecules	372
79	Glossary: molecular markers	374
80	Changing body size of beef cattle in the United States of America	391
81	Calving problems in Belgian White Blue cattle	396
82	Cross-breeding to address inbreeding-related problems in Holstein cattle	397
83	Norwegian Red Cattle – selection for functional traits	399
84	Community-based sheep management in the Peruvian Andes	406
85	Genetic improvement of an indigenous livestock breed – Boran cattle in Kenya	407

86	A llama breeding programme in Ayopaya, Bolivia	408
87	Pastoralists' breeding criteria – insights from a community member	410
88	The Bororo Zebu of the WoDaaBe in Niger – selection for reliability in	
	an extreme environment	412
89	Community-driven breeding programmes for local pig breeds in north Viet Nam	414
90	The cost of heterosis	417
91	Nigeria's Village Poultry Improvement Scheme	417
92	A community-based and participatory dairy goat cross-breeding programme	
	in a low-input smallholder system in the eastern highlands of Kenya	418
93	Economic values	430
94	Glossary: conservation	443
95	Red Maasai sheep – accelerating threats	444
96	Lleyn sheep of Wales – revival in fortunes in tune with modern demands	446
97	Decision-making in conservation and utilization – use of genetic diversity data	452
98	Spatial analysis of genetic diversity	453
99	<i>In situ</i> conservation of the Norwegian Feral Sheep	456
100	Examples of incentive payment schemes at the national level	457
101	An index of economic development potential for targeting <i>in situ</i> conservation	
	investments	458
102	Community-based <i>in situ</i> conservation programme – a case from Patagonia	459
103	Changes in production systems leading to replacement of local buffaloes	
	– a case from Nepal	460
104	Revival of the native Red and White Friesian cattle in the Netherlands	464
	Revival of the Enderby cattle in New Zealand	465
106	Glossary: objective decision aids	468
107	Optimum allocation of conservation funds – an example featuring African	
	cattle breeds	469
108	The Svalbard Global Seed Vault: an international seed depository in the Arctic	472

TABLES

1	Regional overview of Country Reports	xxviii
2	Country Reports received	xxix
3	Reports from international organizations	XXX
4	Origin and domestication of livestock species	7
5	Status of information recorded in the Global Databank for Animal Genetic	
	Resources	23
6	Distribution of mammalian species by region	26
7	Distribution of avian species by region	27
8	Proportion of the world's population size (2005) and number of local and	
	regional transboundary breeds (January 2006) of the major livestock species	
	by region	33
9	Mammalian species – number of reported local breeds	34
10	Avian species – number of reported local breeds	34
11	Mammalian species – number of reported regional transboundary breeds	35

12	Avian species – number of reported regional transboundary breeds	36
13	Mammalian species – number of reported international transboundary breeds	36
14	Avian species – number of reported international transboundary breeds	36
15	Number of extinct mammalian breeds	43
16	Number of extinct avian breeds	43
17	Years of extinction	43
18	Reclassification of regional and international transboundary breeds	
	from 1999 to 2006	45
19	Changes in risk status of transboundary breeds from 1999 to 2006	46
20	Risk status of transboundary breeds reported after 1999	46
21	Changes in risk status of local breeds (1999) reclassified	
	as transboundary breeds (2006)	46
22	Changes in risk status of local breeds from 1999 to 2006	47
23	Risk status of local breeds reported after 1999	47
24	Workforce employed in agriculture and land area per agricultural worker	79
25	Number of animals by species/1000 human population	83
26	Number of animals by species/1000 ha agricultural land	83
27	Production of food of animal origin (kg/person/year)	84
28	Production of fibres, skins and hides (1000 tonnes/year)	87
29	Trends in the use of animals for draught power	88
30	Roles of livestock by livelihood strategy	98
31	Selected studies indicating breed difference in resistance or tolerance	
	to specific diseases	102
32	Mammalian breeds reported to DAD-IS as having resistance or tolerance	
	to specific diseases or parasites	103
33	Breeds reported to DAD-IS as showing resistance or tolerance	
	to trypanosomiasis	104
34	Breeds reported to DAD-IS as showing resistance or tolerance to tick-burden	105
35	Breeds reported to DAD-IS as showing resistance or tolerance	
	to tick-borne diseases	105
36	Breeds reported to DAD-IS as showing resistance or tolerance	
	to internal parasites	106
37	Breeds reported to DAD-IS as showing resistance or tolerance to foot rot	107
38	Cattle breeds reported to DAD-IS as showing resistance or tolerance to leukosis	107
39	Breeds reported to DAD-IS as showing resistance or tolerance to avian diseases	108
40	Impact of recent disease epidemics	128
41	Examples of breeds affected by the FMD outbreak in the United Kingdom	
	in 2001	129
42	Projected trends in meat consumption from 2000 to 2050	142
43	Projected trends in milk consumption from 2000 to 2050	143
44	Standards in the livestock market and implications for small-scale producers	148
45	Trends in production of meat and milk in developing and developed countries	155
46	Livestock numbers and production of the world's livestock production systems	
	– averages for 2001-2003	157
47	The developing countries with the highest meat and milk production (2004)	157
48	Agriculture's contribution to global greenhouse gas and other emissions	162

49	Estimated number of pastoralists in different geographic regions	166
50	Land with rainfed crop production potential	171
51	Main crop-animal interactions in crop-based livestock systems	171
52	Share of irrigated production in total crop production of developing countries	175
53	Sources of information (Country Report sections) for the national-level	
	assessments	189
54	Institutional assessment – infrastructure, capacities and participation	192
55	Institutional assessment – research and knowledge	193
56	Institutional assessment – state of policy development	194
57	Organizations and networks that play or may play a role in animal genetic	
	resources management at regional/subregional level	197
58	Institutional assessment at country level	207
59	List of international organizations and reports on their activities	214
60	Countries prioritizing breeding activities (by species)	217
61	Structured breeding activities for the main livestock species	217
62	Strategies and tools used in cattle breeding	218
63	Training, research and farmers' organizations in current policies	220
64	Stakeholder involvement in the development of animal genetic resources	222
65	Number of countries reporting the use of artificial insemination	224
66	Importance of species and locally adapted versus exotic breeds in	
	current policies	224
67	List of subsample countries that provided information in predefined tables	236
68	Strategies and tools used in sheep breeding	237
69	Strategies and tools used in goat breeding	237
70	Strategies and tools used in pig breeding	238
71	Strategies and tools used in chicken breeding	239
72	Countries reporting structured breeding activities in minor species	239
73	Stakeholder involvement in structured cattle breeding activities	240
74	Stakeholder involvement in structured sheep breeding activities	240
75	Stakeholder involvement in structured goat breeding activities	241
76	Stakeholder involvement in structured pig breeding activities	241
77	Number of countries with conservation programmes	245
78	Conservation activities – at the global level	248
79	Conservation activities in Africa	251
80	Conservation activities in Asia	253
81	Conservation activities in Europe and the Caucasus	256
82	Conservation activities in Latin America and the Caribbean	257
83	Conservation activities in the Near and Middle East	258
84	Conservation activities in North America	259
85	Conservation activities in the Southwest Pacific	260
86	Use of biotechnologies by region	265
87	Use of biotechnologies by species	266
88	Instruments for sustaining livestock production systems	312
89	Instruments in the field of conservation	315
90	Instruments in the field of genetic improvement	317
91	Instruments related to institutions active in genetic improvement	322

92	Instruments in the field of standard setting	323
93	Instruments for promoting trade in livestock products	326
94	Instruments regulating import and export of genetic material	326
95	Instruments regulating livestock movements and import and export of live	
	animals and livestock products	329
96	Regulations in the field of animal health	330
97	Information recorded for mammalian species in the Global Databank for	
	Animal Genetic Resources	351
98	Information recorded for avian species in the Global Databank for	
	Animal Genetic Resources	352
99	Breeding objectives in ruminants	397
100	Breeding objectives in pigs	402
101	Breeding objectives in poultry	403
102	Overview of valuation methodologies	432
103	Conservation benefits and costs under a range of valuation methodologies	
	– the case of the Box Keken pig (Yucatan, Mexico)	435
104	Comparisons of biological, operational and institutional factors influencing	
	plant and animal genetic resources conservation	451
105	Current status of cryoconservation techniques by species	464

FIGURES

1	Assignment of countries to regions and subregions in this report	xxxiii
2	Archaeological map of agricultural homelands and spread of	
	Neolithic/Formative cultures, with approximate radiocarbon dates	5
3	Major centres of livestock domestication – based on archaeological and	
	molecular genetic information	10
4	Origin and migration routes of domestic cattle in Africa	16
5	Proportion of national breed populations for which population figures	
	have been reported	25
6	Regional distribution of major livestock species in 2005	28
7	Distribution of the world's mammalian breeds by species	28
8	Distribution of the world's avian breeds by species	29
9	Number of local and transboundary breeds at global level	32
10	Number of local and transboundary breeds at regional level	32
11	Proportion of the world's breeds by risk status category	38
12	Risk status of the world's mammalian breeds in January 2006: absolute (table)	
	and percentage (chart) figures by species	39
13	Risk status of the world's avian breeds in January 2006: absolute (table) and	
	percentage (chart) figures by species	40
14	Risk status of the world's mammalian breeds in January 2006: absolute (table)	
	and percentage (chart) figures by region	41
15	Risk status of the world's avian breeds in January 2006: absolute (table) and	
	percentage (chart) figures by region	42

16	Local, regional and international breeds in 1999 and 2006	44
17	Changes in risk status of transboundary breeds from 1999 to 2006	45
18	Changes in risk status of local breeds from 1999 to 2006	47
19	Distribution of transboundary breeds	56
20	Distribution of Holstein-Friesian cattle	57
21	Distribution of Charolais cattle	57
22	Distribution of transboundary cattle breeds of Latin American,	
	African or South Asian origin	59
23	Distribution of transboundary sheep breeds	62
24	Gene flow of improved Awassi and Assaf sheep from Israel	64
25	Distribution of Saanen goats	66
26	Distribution of Boer goats	66
27	Distribution of Large White pigs	68
28	Contribution of agriculture and livestock to total GDP by region	78
29	Contribution of livestock to agricultural GDP	79
30	Percentage of permanent pasture in total agricultural land	80
31	Livestock density in relation to human population	81
32	Livestock density per square kilometre of agricultural land	82
33	Net exports – meat	85
34	Net exports – milk equivalent	85
35	Net exports – eggs	86
36	Number of disasters by type and year	121
37	Changes in the meat consumption of developing and developed countries	141
38	Distribution of livestock production systems	154
39	Meat production from ruminants versus monogastrics in developing and	
	developed countries	156
40	Changes in the quantity of cereals used as feed (1992-1994 and 2020)	158
41	Changes in the distribution of the size of pig farms in Brazil (1985 to 1996)	159
42	Estimated contribution of livestock to total phosphate supply on agricultural	
	land in areas presenting a phosphate mass balance of more than 10 kg	
	per hectare in selected Asian countries (1998 to 2000)	161
43	State of institutions – regional comparison	195
44	State of institutions – subregional comparison within Africa	205
45	State of institutions – subregional comparison within Asia	205
46	State of institutions – subregional comparisons within Latin America	
	and the Caribbean	206
47	Information required to design management strategies	348
48	Structure of the poultry breeding industry	389

Acknowledgements

his report could not have been prepared without the assistance of the many individuals who generously contributed their time, energy and expertise. FAO would like to take this opportunity to acknowledge these contributions.

The core of the information for the State of the World's Animal Genetic Resources for Food and Agriculture was provided by the 169 governments that submitted Country Reports; the first and most important acknowledgement therefore goes to these governments and to all those individuals in each country who contributed to these reports, in particular the National Coordinators for the Management of Animal Genetic Resources and the National Consultative Committees. The development of training materials the conduct of training workshops, the preparation and analysis of the Country Reports, the follow-up workshops and the various international, regional and national consultations were facilitated by the following team: Daniel Benitez-Ojeda, Harvey D. Blackburn, Arthur da Silva Mariante, Mamadou Diop, M'Naouer Djemali, Anton Ellenbroek, Erling Fimland, Salah Galal, Andreas Georgoudis, Peter Gulliver, Sipke-Joost Hiemstra, Yusup Ibragimov, Jarmo Juga, Ali Kamali, Sergeij Kharitonov, Richard Laing, Birgitta Malmfors, Moketal Joel Mamabolo, Peter Manueli, Elzbieta Martyniuk, Carlos Mezzadra, Rafael Morales, Ruben Mosi, Siboniso Moyo, David R. Notter, Rafael Núñez-Domínguez, Dominique Planchenault, Geoffrey Pollott, Adrien Raymond, Peter Saville, Hermann Schulte-Coerne, Louise Setshwaelo, Paul Souvenir Zafindrajaona, David Steane, Arunas Svitojus, Lutfi Tahtacioglu, Vijay Taneja, Frank Vigh-Larsen, Hans-Gerhard Wagner, Mateusz Wieczorek, Hongjie Yang and Milan Zjalic. An FAO-WAAP (World Association for Animal Production) agreement assisted a large number of developing countries in report preparation. This important contribution to the reporting process could not have been accomplished without the coordination and hard work of Jean Boyazoglu and his colleagues at WAAP.

The State of the World's Animal Genetic Resources for Food and Agriculture was prepared and coordinated by Barbara Rischkowsky with the assistance of Dafydd Pilling. The preparation was facilitated and supported by the Service Chief of Animal Production, Irene Hoffmann, and current and former officers of the Animal Genetic Resources Group: Badi Besbes, David Boerma, Ricardo Cardellino, Mitsuhiro Inamura, Pal Hajas, Keith Hammond, Manuel Luque Cuesta, Beate Scherf, Kim-Anh Tempelman and Olaf Thieme. Administrative and secretarial support was provided by Carmen Hopmans and Kafia Fassi-Fihri. The finalization, layout and printing were supervised by Beate Scherf.

The sections of the report were prepared and reviewed by individual experts or expert teams who will be acknowledged below by section. This form of acknowledgement intends to thank the authors for contributing their time, expertise and energy, both in the process of writing, and in reviewing and editing. It will also allow the interested public to identify resource persons for specific topics. This is facilitated by an alphabetical list of authors and reviewers on the attached CD-ROM.

Case studies were prepared by: Camillus O. Ahuya, Tony Bennett, Ismaïl Boujenane, Achilles Costales, Erling Fimland, Cary Fowler, John Gibson, Alexander Kahi, John M. King, Saverio Krätli, Maria Rosa Lanari, Ute Lemke, Thomas Loquang, Manuel Luque Cuesta, Paolo Ajmone Marsan, André Markemann, Marnie Mellencamp, Okeyo Mwai, Kor Oldenbroek, John Bryn Owen, Vincente Rodríguez-Estévez, Hans Schiere, Marianna Siegmund-Schulze, Henner Simianer, David Steane, Angelika Stemmer, Kim-Ahn Tempelman, Hongjie Yang and Anne Valle Zárate.

Additional material for the preparation of text boxes was provided by Brian Donahoe, Morgan Keay, Juhani Mäki-Hokkonen, Kirk Olson and Dan Plumley.

Data entry into the Global Databank was carried out by Ellen Geerlings and Lucy Wigboldus. Analysis of the Global Databank was performed by Mateusz Wieczorek, Alberto Montironi, Justyna Dybowska, Kerstin Zander and Beate Scherf. All maps (if not otherwise stated) were prepared by Thierry Lassueur with support from Tim Robinson and Pius Chilonda.

Thematic studies were coordinated by Beate Scherf and Irene Hoffmann and prepared by: Erika Alandia Robles, Simon Anderson, Kassahun Awgichew, Roswitha Baumung, P.N. Bhat, Stephen Bishop, Kwame Boa-Amponsem, Ricardo Cardellino, Arthur da Silva Mariante, Mart de Jong, Adam G. Drucker, Christian Gall, Michael Goe, Elisha Gootwine, Douglas Gray, Claire Heffernan, Sipke-Joost Hiemstra, Sabine Homann, Christian G. Hülsebusch, Le Thi Thanh Huyen, Antonella Ingrassia, Ute Lemke, Nils Louwaars, Daniele Manzella, Jacobus Hendrik Maritz, Elzbieta Martyniuk, Marcus Mergenthaler, Klaus Meyn, Giulietta Minozzi, H. Momm, Katinka Musavaya, David R. Notter, Kor Oldenbroek, Marta Pardo Leal, Roswitha Roessler, Cornelia Schäfer, Kim-Anh Tempelman, Morton W. Tvedt and Anne Valle Zárate.

Subregional factsheets presented on the attached CD-ROM were prepared by Marieke Reuver, Marion De Vries, Harvey Blackburn, Campbell Davidson, Salah Galal, Ellen Geerlings and National Coordinators from Europe and the Caucasus. Reports on subregional priorities were compiled by Milan Zjalic.

Graphic design and layout was by Omar Bolbol and Daniela Scicchigno.

Listing every person by name is not easy, and carries with it the risk that someone may be overlooked. Apologies are conveyed to anyone who may have provided assistance whose name has been inadvertently omitted. 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.

Part / Section	Authors	Reviewers
		Reviewers
PART 1: The state of agricultural biodiversity		
Origin and history of livestock diversity	Olivier Hanotte	Ilse Koehler-Rollefson
Status of animal genetic resources	Barbara Rischkowsky, Dafydd Pilling, Beate Scherf	Mateusz Wieczorek
Flows of animal genetic resources	Evelyn Mathias, Ilse Koehler-Rollefson, Paul Mundy	Beate Scherf, Annette von Lossau
Uses and values of animal genetic resources	Dafydd Pilling, Barbara Rischkowsky with Manuel Luque Cuesta	
Animal genetic resources and disease resistance	Dafydd Pilling, Barbara Rischkowsky	Steve Bishop, Jan Slingenbergh
Threats to livestock genetic diversity	Dafydd Pilling, Claire Heffernan, Michael Goe	Anni McLeod, Simon Mack, Jan Slingenbergh
PART 2: Livestock sector trends		
	Pierre Gerber, Dafydd Pilling, Barbara Rischkowsky	Hans Schiere
PART 3: The state of capacities in animal ger	netic resources management	
Institutions and stakeholders	Maria Brockhaus	Irene Hoffmann, Beate Scherf, Ricardo Cardellino, Jean Boyazoglu, Annette von Lossau, Ilse Koehler-Rollefson
Structured breeding programmes	Olaf Thieme	Juhani Mäki-Hokkonen
Conservation programmes	Kor Oldenbroek with Milan Zjalic	
Reproductive and molecular biotechnology	Dafydd Pilling with Milan Zjalic	Salah Galal
Legislation and regulation		
International legal framework – major instruments	Dafydd Pilling drawing on FAO legislative study No 89	Clive Stannard, Niels Louwaars
Patenting – an emerging legal issue	Dafydd Pilling with Claudio Chiarolla	Niels Louwaars, Morten Walløe Tvedt
Regulatory frameworks at regional level	Dafydd Pilling drawing on FAO legislative study No 89	Sipke Joost Hiemstra, Danielle Manzella, Hermann Schulte-Coerne, Kai-Uwe Sprenger
National legislation and policy	Susette Biber-Klemm with Cari Rincker	

Part / Section	Authors	Reviewers			
PART 4: The state of the art in animal genetic	PART 4: The state of the art in animal genetic resources management				
Basic concepts	Barbara Rischkowsky, Dafydd Pilling	Beate Scherf, Ricardo Cardellino			
Methods for characterization	Workneh Ayalew, Beate Scherf, Barbara Rischkowsky	Ed Rege			
Molecular markers – a tool for exploring genetic diversity	Paolo Ajmone Marsan, with Kor Oldenbroek	Han Jianlin, Paul Boettcher			
Genetic improvement methods to support sustainable utilization	Badi Besbes, Victor Olori, Jim Sanders	Beate Scherf, Ricardo Cardellino, Keith Hammond			
Methods for economic valuation	Adam Drucker	Gianni Cicia			
Methods for conservation	Jean-Pierre Brillard, Gustavo Gandini, John Gibson, David Notter, Dafydd Pilling, Barbara Rischkowsky, Henner Simianer	Workneh Ayalew, Harvey Blackburn, Jean Boyazoglu, Ricardo Cardellino, Coralie Danchin, Sipke Joost Hiemstra, Elzbieta Martyniuk, Roger Pullin, Beate Scherf, Michele Tixier-Boichard			
Research priorities	all authors	all reviewers			
PART 5: Needs and challenges in animal gen	etic resources management				
	Barbara Rischkowsky, Irene Hoffmann	Animal Genetic Resources Group and CGRFA Secretariat			

Preface

gricultural biodiversity is the product of thousands of years of activity during which humans have sought to meet their needs in a wide range of climatic and ecological conditions. Well-adapted livestock have been an essential element of agricultural production systems, particularly important in harsh environments where crop farming is difficult or impossible.

The capacity of agro-ecosystems to maintain and increase their productivity, and to adapt to changing circumstances, remains vital to the food security of the world's population. For livestock keepers, animal genetic diversity is a resource to be drawn upon to select stocks and develop new breeds. More broadly, genetically diverse livestock populations provide society with a greater range of options to meet future challenges.

The Food and Agriculture Organization of the United Nations (FAO) has, since the early 1960s, provided assistance to countries to characterize their animal genetic resources for food and agriculture (AnGR) and develop conservation strategies. In 1990, FAO's Council recommended the development of a comprehensive programme for the sustainable management of AnGR at the global level. A meeting of experts in 1992, and subsequent sessions of FAO's governing bodies, provided impetus to the development of the Global Strategy for the Management of Farm Animal Genetic Resources, which was initiated in 1993. The Animal Production and Health Division of FAO was designated as the Global Focal Point for Animal Genetic Resources, and given the role of coordinating further development of the Global Strategy. In 1995, the Twenty-eighth Session of the FAO Conference took the decision to broaden the mandate of the Commission on Plant Genetic Resources to cover all aspects of agro-biodiversity of relevance to food and agriculture; the Commission, originally established in 1983, was the first permanent intergovernmental forum dealing with agricultural genetic resources. Work on AnGR was the first element of this expanded role. The Commission was renamed the Commission on Genetic Resources for Food and Agriculture (CGRFA).

The international agenda

FAO's commitment to maintaining agricultural biodiversity is consistent with the increasing prominence of biodiversity on the agenda of the international community. This development is the result of a recognition that threats to biodiversity are increasing, whether measured in terms of the extinction of species, the destruction of ecosystems and habitats, or the loss of genetic diversity within the species utilized for agriculture. The 1992 United Nations Conference on Environment and Development (Earth Summit) held in Rio de Janeiro was an important landmark. The Convention on Biological Diversity (CBD), signed in Rio by 150 governments, committed the nations of the world to conserve their biodiversity, to ensure its sustainable use, and to provide for equitable sharing of the benefits arising from its use. By 2005, 188 countries had become Parties to the CBD. The Conference of Parties (COP) of the CBD (the governing body of the Convention) has specifically recognized the special nature of agricultural biodiversity and the need for distinctive solutions in this field (see for example decision V/5, taken at the Fifth Meeting of the COP in 2000).

Agenda 21, adopted by 179 governments at the time at Rio Earth Summit in 1992, is a plan of action to be undertaken at global, national and local levels by governments, the organizations of the United Nations System and other stakeholders, to address all areas of human impact on the environment. The Agenda's Chapter 14, "Promoting Sustainable Agriculture and Rural Development", addresses the question of increasing food production

and enhancing food security in a sustainable way. It included programme areas related to the conservation and development of AnGR.

The threat to food security posed by the loss of biodiversity was noted in the Plan of Action adopted at the 1996 World Food Summit held in Rome. Under Objective 3.2(f) of the Rome Declaration, the governments of the world affirmed that they would "promote the conservation and sustainable utilization of animal genetic resources."

Meeting the Millennium Development Goals, adopted by the United Nations in 2000, presents another great challenge to the international community. The adverse effects of biodiversity loss on progress towards the achievement of these goals are cause for concern (UNDP, 2002)¹. As well as underpinning food security, biological diversity is the basis of many economic activities, and is vital to ecosystem functioning. Declining biodiversity tends to be associated with greater shocks and fluctuations in ecosystems, and it is the poor that are usually the most vulnerable to these effects. Many poor people are closely dependent on natural resources for their livelihoods, and frequently have a wealth of knowledge regarding the plants and animals with which they work. It has been suggested that this knowledge could be a source of income for the poor if it leads to the development and marketing of unique biological products. In reality, the extent to which the benefits of such developments actually accrue to the poor is often limited – highlighting the need not only for conservation of biodiversity, but for equitable frameworks for its utilization.

Within the international framework for the management and conservation of biological diversity, the work of CGRFA focuses on the particular features and problems associated with the management of agro-biodiversity, and the need for distinctive solutions for this field.

¹ UNDP. 2002. Building on hidden opportunities to achieve the Millenium Development Goals. Poverty reduction through sustainable biodiversity use, by I Koziell & C.I. McNeill. New York.

The reporting and preparatory process

n 1999, the CGRFA during its Eighth Regular Session agreed that FAO should coordinate the preparation of a country-driven report on the State of the World's Animal Genetic Resources for Food and Agriculture (SoW-AnGR)². In 2004, the Intergovernmental Technical Working Group on Animal Genetic Resources (ITWG-AnGR) – a subsidiary body established by the Commission to address issues relevant to the conservation and sustainable use of AnGR – reviewed progress in the preparation of the SoW-AnGR and endorsed a draft outline including a Report on Strategic Priorities for Action. The CGRFA subsequently endorsed this outline at its Tenth Regular Session. The agreed timetable for the preparation of the SoW-AnGR was that a draft would be available for review by the CGRFA at its Eleventh Regular Session in 2007, and that the report would be finalized at the first International Technical Conference on Animal Genetic Resources.

The first draft of the SoW-AnGR was made available to the Fourth Session of the ITWG-AnGR in December 2006. The Working Group requested more time to undertake a review of the report. It was agreed that members of the Working Group would provide comments on the draft to FAO by 31 January 2007, in order for FAO to undertake any necessary revisions prior to the presentation of the SoW-AnGR to the CGRFA at its Eleventh Regular Session. The Working Group further agreed that the review process should be open to all Member Countries of the Commission. FAO, therefore, invited all CGRFA Member Countries to submit comments within the agreed time frame.

Inputs to the State of the World's Animal Genetic Resources reporting process

The process of preparing the SoW-AnGR included a number of elements through which the information required was gathered and analysed.

Country Reports

In order to ensure the country-driven nature of the process, in March 2001, FAO invited 188 countries to submit Country Reports assessing their AnGR. Guidelines for the preparation of the Country Reports were produced, including a proposed structure. Regional training and follow-up workshops were conducted between July 2001 and November 2004. The overall objectives of the Country Reports were to analyse and report on the state of AnGR, on the status and trends of these resources, and on their current and potential contribution to food, agriculture and rural development; to assess the state of countries' capacity to manage AnGR, in order to determine priorities for future capacity-building; and to identify national priorities for action in the field of conservation and sustainable utilization of AnGR, and related requirements for international cooperation. The first Country Reports were received in the second half of 2002, with the majority being submitted during 2003 and 2004. The latest Country Report was submitted in October 2005, bringing the total to 169 (Tables 1 and 2).

The fact that the submission of the Country Reports was spread over several years meant that as the process of preparing the SoW-AnGR progressed, more information became available for analysis. For this reason, it should be noted that the latest arrivals among the Country Reports could not be fully included in the process of analysis and report preparation.

² The term animal genetic resources (AnGR) as applied throughout the report is an abbreviation of animal genetic resources used for food and agriculture and excludes fish.

The length of the reporting process also means that the information presented in the SoW-AnGR does not necessarily reflect the very latest developments in the state of institutions and capacity at the national level.

TABLE 1Regional overview of Country Reports

Region ³ COUNTRY REPORTS			
	Subn	nitted	Total
	Final	Draft	
Africa	45	4	49
Asia	22	4	26
Europe and the Caucasus	38	3	41
Latin America and the Caribbean	21	9	30
Near and Middle East	6	3	9
North America	2	0	2
Southwest Pacific	9	3	12
Total	143	26	169

Reports received by 31 December 2005.

 $^{^{3}}$ Note that these regions do not correspond to the usual FAO regions; see below for further explanation.

TABLE 2
Country Reports received

Country Reports received				
Region	Countries			
Africa (49)	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Swaziland, Togo, Tunisia, Uganda, United Republic of Tanzania, Zambia, Zimbabwe			
Asia (26)	Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Iran (Islamic Republic of), Japan, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Sri Lanka, Tajikistan, Turkmenistan, Uzbekistan, Viet Nam			
Europe and the Caucasus (41)	Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia and Montenegro ⁴ , Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine, United Kingdom			
Latin America and the Caribbean (30)	Antigua and Barbuda, Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of)			
Near and Middle East (9)	Egypt, Iraq, Jordan, Lebanon, Libyan Arab Jamahiriya, Oman, Sudan, Syrian Arab Republic, Yemen			
North America (2)	Canada, United States of America			
Southwest Pacific (12)	Australia, Cook Islands, Fiji, Kiribati, Niue, Northern Mariana Islands, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu			

Reports received by 31 December 2005.

Reports from international organizations

Following a request from the ITWG, in August 2004, FAO invited 77 international organizations to submit a report of their work in the field of AnGR, as a contribution to the SoW-AnGR. These reports were to cover activities such as research, extension, education, training, public awareness, communications and advocacy, and also to include a description of the organization and information on institutional capacities which support activities in AnGR. Specific subjects to be described included (if applicable) inventory and characterization, sustainable use and development, conservation, valuation, policy and legislation, documentation and information databases, animal and human health, and food safety, as well as opportunities and proposals for interaction with other organizations and United Nations agencies. As of June 2006, nine organizations had submitted reports (Table 3). Reports were received from four international non-governmental organizations, three intergovernmental organizations, and two research organizations. A further three international organizations informed FAO that they were not engaged in AnGR-related activities.

⁴ Since June 2006 Serbia and Montenegro have become independent states. However, in the SoW-AnGR they are still treated as one country, as in Country Report submitted to FAO.

TABLE 3Reports from international organizations

Organization	Title of the submission	Received
CGIAR Centres	Consultative Group on International Agricultural Research (CGIAR) Centres Report to FAO for input into the SoW and the draft report on strategic priorities for action on FAnGR Section I: Description of the CGIAR Institutes and Programmes	May 2004
SAVE Foundation	SAVE Foundation (Safeguard for Agricultural Varieties in Europe) Brief Portrait April 2004	May 2004
D8 Countries	Report on Animal Genetic Resources in the D-8 Countries – Strategic Priorities for Action; and Reports D8 Seminar on Conservation of Farm Animal Genetic Resources Cairo, Egypt, 11–13 January 2004 D8 Seminar on Conservation of Farm Animal Genetic Resources, Islamabad, Pakistan, 1–3 August 2002; Report on Workshop on Food Security in D 8 countries, Babolsar, Islamic Republic of Iran, 16–20 October 2000 Report on Workshop on Food Security in D 8 countries, Islamabad, Pakistan, 24–26 November 1999	June 2004 September 2004
LPP	League for Pastoral Peoples Report on Activities of the League for Pastoral Peoples	November 2004
OIE	World Organisation for Animal Health (OIE) Oral presentation to the Commission on Genetic Resources for Food and Agriculture, 10th Session (to be used thereafter as the OIE input in reply to the FAO AN21/47 request)	November 2004
ACSAD	Arab Center for the Studies of Arid zones and Dry lands (ACSAD) The Activities of the Arab Center for the Studies of Arid zones and Dry lands concerning the Animal Genetic Resources	December 2004
IAMZ	The Mediterranean Agronomic Institute of Zaragoza (IAMZ) Report on Training activities	January 2005
EAAP	EAAP (European Association for Animal Production) Report of the Working Group on Animal Genetic Resources	February 2005
ISAG	International Society for Animal Genetics (ISAG) Report of the ISAG/FAO advisory group on animal genetic diversity	March 2005

Thematic studies

In addition to the Country Reports and the reports from international organizations, a number of thematic studies were commissioned by FAO. These studies were intended to contribute to the understanding of specific topics likely not to be covered in Country Reports, but relevant to the preparation of the SoW-AnGR. During the period 2002 to 2006, 12 thematic studies were prepared:

- Opportunities for incorporating genetic elements into the management of farm animal diseases: policy issues. A review paper on the potential of genetic elements in the management of disease, technical opportunities, and benefits arising from the incorporation of these elements in effective disease management⁵ (2002);
- Measurement of domestic animal diversity (MoDAD) a review of recent diversity studies. A survey evaluating the current status of molecular genetic research in domestic animal species, with emphasis on characterization of AnGR⁶ (2004);

⁵ Background Study Paper No. 18

⁶ CGRFA/WG-AnGR-3/04 inf. 3

- The economics of farm animal genetic resource conservation and sustainable use: why is it important and what have we learned? A study on the valuation of AnGR, summarizing methodological approaches and knowledge gaps⁷ (2004);
- Conservation strategies for animal genetic resources. A study contrasting
 opportunities, challenges, biological characteristics, institutional infrastructure and
 operational considerations influencing management of plant and animal genetic
 resources⁸ (2004);
- Environmental effects on animal genetic resources. An evaluation and synthesis of the evidence available on a spectrum of environmental factors and their effects on AnGR at the individual animal and the breeding population levels⁹ (2004);
- The legal framework for the management of animal genetic resources. An introductory study of policy and legal frameworks for the management of AnGR including a survey of countries in different world regions¹⁰ (2004, printed revised version 2005);
- The impact of disasters and emergencies on animal genetic resources. A study which provides an overview of potential disasters and their possible impact on AnGR. It also provides an analysis of the effects of emergency responses. It proposes decision-support guidelines for disaster management¹¹ (2006);
- The state of development of biotechnologies as they relate to the management of animal genetic resources and their potential application in developing countries. An introductory study of biotechnology applications and their use in developing countries, which includes information provided in Country Reports¹² (2006);
- Exchange, use and conservation of animal genetic resources: policy and regulatory options. A study which identifies how exchange practices related to AnGR affect the various stakeholders in the livestock sector (2006);
- A strategic approach for conservation and continued use of farm animal genetic resources. A study which outlines patterns of change in AnGR use and their impact on conservation. It summarizes current experience, and the capacity of alternative conservation measures, considering the needs and aspirations of the various stakeholders whose livelihoods depend on animal production¹³ (2006);
- People and animals. Traditional livestock keepers: guardians of domestic animal diversity. A documentation of 13 case studies from all over the world on how communities manage their local AnGR, demonstrating the value of local knowledge in preserving the equilibrium between farmers, animals and environment¹⁴ (2007);
- Gene flow in animal genetic resources. A study on status, impact and trends. A study providing analysis of the magnitude and direction of movement of genetic material of the four major farm animal species: cattle, pigs, goats, and sheep. Determining factors are identified and selected; examples of impacts on economic development, poverty reduction and biodiversity in developing countries are presented (2007).

⁷ Background Study Paper No. 21

⁸ Background Study Paper No. 22

⁹ Background Study Paper No. 28

¹⁰ Background Study Paper No. 24

¹¹ Background Study Paper No. 32

¹² Background Study Paper No. 33

 $^{^{13}}$ CGRFA/WG-AnGR-4/06/Inf.6

¹⁴ FAO Inter-Departmental Working Group on Biological Diversity for Food and Agriculture

Preparation of the report

Sources of information

Different sections of the SoW-AnGR required different approaches. Some sections were largely based on the information provided in the 148 Country Reports available by June 2005. Other sections drew heavily on the wider literature or on expert knowledge rather than on the information gathered specifically for the SoW-AnGR process. FAO's Domestic Animal Diversity Information System (DAD-IS)¹⁵ and the FAOSTAT¹⁶ statistical database were also utilized. Regional e-mail consultations, organized by FAO in late 2005 to review the draft Report on Strategic Priorities for Action, provided an additional source of information, particularly on institutional capacities.

Part 1 describes the state of agricultural diversity in the livestock sector. The chapter draws on a number of sources. The description of AnGR inventory and of the extent of genetic erosion is based on information drawn from DAD-IS. This information system, which was launched in 1996, enables National Coordinators for the Management of Animal Genetic Resources to update their national breed databank via the Internet. The guidelines for the development of Country Reports encouraged countries to report breed-related data and information directly to DAD-IS, and not to include details of breeds in the Country Reports. Nonetheless, the Country Reports contained a wealth of breed-related information that was not reported to DAD-IS. As a result of this development, and in order to ensure that the analysis for the SoW-AnGR was based on the most up-to-date information available, FAO provided for the extraction of these data from Country Reports and their entry into DAD-IS. National Coordinators were then requested to validate and further complete their national breed databanks. It was also thought desirable to enable the analysis for the SoW-AnGR to be based on breeds and not only on national breed populations; i.e. that populations of the same breed in different countries were not counted as separate breeds. To this end, linkages between breed populations in different countries were introduced into the Global Databank, based on information on names, origin and development, importation and geographic location. Lists of all national breed populations and their proposed linkages were sent to National Coordinators for review. The analysis of the data for the purposes of the SoW-AnGR was carried out in January 2006, by which time data from all 169 Country Reports had been entered into the system.

The section on uses and values of AnGR is based on FAOSTAT for population and production statistics, and on the Country Reports for more qualitative information on livestock functions. The section on genetic resistance to disease draws on DAD-IS and the wider scientific literature. Broader sources were also used to describe the origin and domestication of AnGR, sharing and exchange of AnGR, and threats to AnGR.

Part 2 describes livestock sector trends and their implications for AnGR, and draws on a wide range of literature and statistics.

Part 3 describes the state of human capacity, breeding and conservation strategies, legislation and the use of biotechnologies. This part of the report is largely based on the information in the Country Reports. However, the sections on regional and international legislation, and emerging legal and policy issues draw on wider sources.

¹⁵ http://www.fao.org/dad-is/

¹⁶ http://faostat.fao.org/

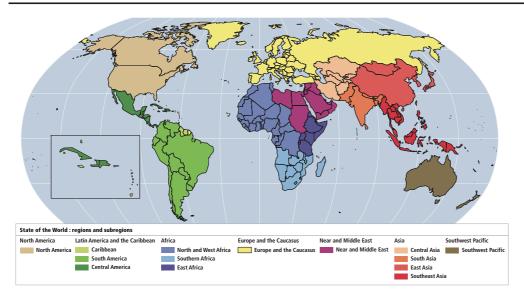
Part 4 on the state of the art in AnGR management is largely based on the wider scientific literature. For the preparation of the section on the state of the art in AnGR conservation, an expert meeting was convened at FAO in Rome, in July 2005. The participants discussed the approach to the section and allocated writing tasks. The first draft was reviewed by all members in the writing group in October 2005. In November 2005, a workshop "Options and Strategies for the Conservation of Farm Animal Genetic Resources" took place in Montpellier, France. The participants at this workshop were given the opportunity to review the revised version of the conservation section.

Part 5 analyses needs and challenges for AnGR management, based on the evidence provided in the other chapters of the report. This analysis relates the current state of erosion and threats to AnGR to current capacities in AnGR management and the state of knowledge regarding methodologies and their application.

Regional classification of countries

The assignment of countries to the regions and subregions used for the purposes of the SoW-AnGR was based on a number of factors that influence biodiversity, including production environments, cultural specificities and the distribution of shared AnGR. Future collaboration in the establishment of Regional Focal Points was also considered, as was the experience gained from the process of convening SoW-AnGR subregional follow-up workshops in 2003 and 2004. Thus, the assignments do not follow exactly the standard FAO regions used in FAO statistics or for FAO election purposes (although for most countries the assignment does not differ from the standard classification). The proposed classification was reviewed at a meeting of Regional Facilitators on "Strategy for Regional Consultations" held in August 2005. The resulting classification distinguishes seven regions, of which three regions were further subdivided: Africa (East Africa, North and West Africa, Southern Africa); Asia (Central Asia, East Asia, Southeast Asia, South Asia); Europe and the Caucasus; Latin America and the Caribbean (Caribbean, Central America, South America); the Near and Middle East; North America; and the Southwest Pacific.

FIGURE 1 Assignment of countries to regions and subregions in this report



Executive summary

he State of the World's Animal Genetic Resources for Food and Agriculture is the first global assessment of livestock biodiversity. Drawing on 169 Country Reports, contributions from a number of international organizations and twelve specially commissioned thematic studies, it presents an analysis of the state of agricultural biodiversity in the livestock sector – origins and development, uses and values, distribution and exchange, risk status and threats – and of capacity to manage these resources – institutions, policies and legal frameworks, structured breeding activities and conservation programmes. Needs and challenges are assessed in the context of the forces driving change in livestock production systems. Tools and methods to enhance the use and development of animal genetic resources are explored in sections on the state of the art in characterization, genetic improvement, economic evaluation and conservation.

Thousands of years of animal husbandry and controlled breeding, combined with the effects of natural selection, have given rise to great genetic diversity among the world's livestock populations. High-output animals – intensively bred to supply uniform products under controlled management conditions – co-exist with the multipurpose breeds kept by small-scale farmers and herders mainly in low external input production systems.

Effective management of animal genetic diversity is essential to global food security, sustainable development and the livelihoods of hundreds of millions of people. The livestock sector and the international community are facing many challenges. The rapidly rising demand for livestock products in many parts of the developing world, emerging animal diseases, climate change and global targets such as the Millennium Development Goals need to be urgently addressed. Many breeds have unique characteristics or combinations of characteristics – disease resistance, tolerance of climatic extremes or supply of specialized products – that could contribute to meeting these challenges. However, evidence suggests that there is ongoing and probably accelerating erosion of the genetic resource base.

FAO's Global Databank for Animal Genetic Resources for Food and Agriculture contains information on a total of 7 616 livestock breeds. Around 20 percent of reported breeds are classified as at risk. Of even greater concern is that during the last six years 62 breeds became extinct – amounting to the loss of almost one breed per month. These figures present only a partial picture of genetic erosion. Breed inventories, and particularly surveys of population size and structure at breed level, are inadequate in many parts of the world. Population data are unavailable for 36 percent of all breeds. Moreover, among many of the most widely used high-output breeds of cattle, within-breed genetic diversity is being undermined by the use of few highly popular sires for breeding purposes.

A number of threats to genetic diversity can be identified. Probably the most significant is the marginalization of traditional production systems and the associated local breeds, driven mainly by the rapid spread of intensive livestock production, often large-scale and utilizing a narrow range of breeds. Global production of meat, milk and eggs is increasingly based on a limited number of high-output breeds – those that are most profitably utilized in industrial production systems. The intensification process has been driven by rising demand for animal products and has been facilitated by the ease with which genetic material, production technologies and inputs can now be moved around the world. Intensification and industrialization have contributed to raising the output of livestock production and to feeding the growing human population. However, policy measures are necessary to minimize the potential loss of the global public goods embodied in animal genetic resource diversity.

Acute threats such as major disease epidemics and disasters of various kinds (droughts, floods, military conflicts, etc.) are also a concern – particularly in the case of small, geographically concentrated breed populations. Threats of this kind cannot be eliminated, but their impacts can be mitigated. Preparedness is essential in this context as ad hoc actions taken in an emergency situation will usually be far less effective. Fundamental to such plans, and more broadly to the sustainable management of genetic resources, is improved knowledge of which breeds have characteristics that make them priorities for conservation, and how they are distributed geographically and by production system.

Policies and legal frameworks influencing the livestock sector are not always favourable to the sustainable utilization of animal genetic resources. Overt or hidden governmental subsidies have often promoted the development of large-scale production at the expense of the smallholder systems that utilize local genetic resources. Development interventions and disease control strategies can also pose a threat to genetic diversity. Development and post-disaster rehabilitation programmes that involve livestock should assess their potential impacts on genetic diversity and ensure that the breeds used are appropriate to local production environments and the needs of the intended beneficiaries. Culling programmes implemented in response to disease outbreaks need to incorporate measures to protect rare breeds; revision of relevant legislation may be necessary.

Where the evolution of livestock production systems threatens the ongoing use of potentially valuable genetic resources, or to safeguard against sudden disastrous losses, breed conservation measures have to be considered. In vivo conservation options include dedicated conservation farms or protected areas, and payments or other support measures for those who keep rare breeds within their production environments. In vitro conservation of genetic material in liquid nitrogen can provide a valuable complement to in vivo approaches. Where feasible, facilitating the emergence of new patterns of sustainable utilization should be an objective. Particularly in developed countries, niche markets for specialized products, and the use of grazing animals for nature or landscape management purposes, provide valuable opportunities. Well-planned genetic improvement programmes will often be essential if local breeds are to remain viable livelihood options for their keepers.

Implementing appropriate strategies for the low external input production systems of the developing world is a great challenge. Pastoralists and smallholders are the guardians of much of the world's livestock biodiversity. Their capacity to continue this role may need to be supported – for example by ensuring sufficient access to grazing land. At the same time, it is essential that conservation measures do not constrain the development of production systems or limit livelihood opportunities. A small number of community-based conservation and breeding programmes have begun to address these issues. The approach needs to be further developed.

Effective management of animal genetic diversity requires resources – including well-trained personnel and adequate technical facilities. Sound organizational structures (e.g. for animal recording and genetic evaluation) and wide stakeholder (particularly breeders and livestock keepers) involvement in planning and decision-making are also essential. However, throughout much of the developing world, these prerequisites are lacking. Forty-eight percent of the world's countries report no national-level in vivo conservation programmes, and sixty-three percent report that they have no in vitro programmes. Similarly, in many countries structured breeding programmes are absent or ineffective.

In a time of rapid change and widespread privatization, national planning is needed to ensure the long-term supply of public goods. Livestock-sector development policies should support equity objectives for rural populations so that these populations are able to build up, in a sustainable way, the productive capacity required to enhance their livelihoods and supply the goods and services needed by the wider society. The management of animal genetic resources needs to be balanced with other goals within the broader rural and agricultural development framework. Careful attention must be paid to the roles, functions and values of local breeds and to how they can contribute to development objectives.

The countries and regions of the world are interdependent in the utilization of animal genetic resources. This is clear from evidence of historic gene flows and current patterns of livestock distribution. In the future, genetic resources from any part of the world may prove vital to breeders and livestock keepers elsewhere. There is a need for the international community to accept responsibility for the management of these shared resources. Support for developing countries and countries with economies in transition to characterize, conserve and utilize their livestock breeds may be necessary. Wide access to animal genetic resources - for farmers, herders, breeders and researchers - is essential to sustainable use and development. Frameworks for wide access, and for equitable sharing of the benefits derived from the use of animal genetic resources, need to be put in place at both national and international levels. It is important that the distinct characteristics of agricultural biodiversity - created largely through human intervention and requiring continuous active human management - are taken into account in the development of such frameworks. International cooperation, and better integration of animal genetic resources management into all aspects of livestock development, will help to ensure that the world's wealth of livestock biodiversity is suitably used and developed for food and agriculture, and remains available for future generations.