Section B

Characterization, inventory and monitoring

1 Introduction

Characterization, inventory and monitoring of animal genetic resources (AnGR) are essential to their sustainable management. Information on breeds' characteristics facilitates effective planning of how and where they can best be used and developed. Assessing risk status (the likelihood that breeds will become extinct if no remedial action is taken) is a key element of AnGR management at national level. This requires information on the size and structure (number of female and male breeding animals, proportion of females breeding pure, total number of herds, geographical distribution, etc.) of breed populations and how these change over time. A range of different approaches and specific tools are available for use in gathering information on the characteristics of individual animals and livestock populations (FAO, 2011a; 2011b; 2012). The state of the art in this field is described in Part 4 Sections A and B, the latter focusing specifically on molecular genetic tools.

This section provides an overview of the state of implementation of characterization, inventory and monitoring activities, based on the information provided in the country reports (see the introduction to Part 3 for an overview of the country coverage and the use of the national breed population as a unit of analysis). The country-report questionnaire included two subsections focused on characterization activities. The first of these requested countries to provide information on the extent to which their national breed populations have been subject to various types of characterization study (see Box 3B1). Countries were obliged to provide this information for the "big five" livestock species (cattle, sheep, goats, pigs and chickens). Providing information on other species was optional. The other subsection addressed countries' progress in implementing Strategic Priority Area 1 of the Global Plan of Action for Animal Genetic Resources (Characterization, Inventory and Monitoring of Trends and Associated Risks). In this subsection, countries were required to report on the state of development of institutional and organizational arrangements for activities in this field, as well as on the state of implementation of various activities. Countries also had the opportunity to describe constraints to the implementation of activities in this strategic priority area. Detailed analysis is provided in the *Synthesis progress report on the implementation of the Global Plan of Action for Animal Genetic Resources – 2014* (FAO, 2014a).

2 Development of national breed inventories

A national breed inventory is a comprehensive list of the breeds present in a country. Given that the breed is the unit of management for many AnGR-related activities, including conservation programmes, establishing a complete inventory is an important objective. Figure 3B1 presents a region by region summary of the reported state of countries' national breed inventories, including whether or not progress has been made since the adoption of the Global Plan of Action. The results show that while many countries have made progress in improving their inventories in

Box 3B1
Characterization – definitions of terms

Baseline survey of population size: A survey that obtains sufficient population data to determine a breed's risk status at national level. It provides a reference point for monitoring population trends.
Monitoring of population size: A systematic set of activities undertaken to document changes in population size and structure over time.
Phenotypic characterization: The process of identifying distinct populations and describing their morphological and production characteristics within given production environments; it includes the description of breeds' production environments and recording of their geographical distributions.
Genetic diversity studies based on pedigree: Studies that involve estimating genetic relationships among animals based on the probabilities of their sharing alleles from common ancestors. At breed level, average coefficients of inbreeding and/or kinships and their trends over time are the most commonly used measures.
Molecular genetic diversity studies within breed: Studies that involve the genotyping of individual animals within a breed for a set of molecular markers, for the purpose of evaluating diversity within the breed. At breed level, heterozygosity is the most simple and meaningful parameter used. Higher heterozygosity indicates higher diversity. Breed genetic structure can be studied by comparing observed and expected heterozygosity (predicted according to sample size and allelic frequencies) and by measuring relationships between animals (proportion of shared alleles across the markers). This provides information on possible population fragmentation or recent cross-breeding events important for the future of the breed.
Molecular genetic diversity studies between breeds: Studies that involve the genotyping of representative groups of animals from a group of breeds for the purpose of evaluating genetic similarity between the breeds. Genetic distance, a measure of the similarity of the allele frequencies between breeds, is a parameter commonly used to measure relationships between breeds. Introgression between populations can be detected by such studies.
Genetic variance components estimation: Use of pedigree and performance data to estimate which part of the phenotypic variance in a population is under genetic control.
Molecular genetic evaluation: The inclusion of molecular genetic information in the procedure for genetic evaluation. This may be limited to genotypes for a few specific genes or extended to the prediction of "genomic breeding values" by using information from large panels of single nucleotide polymorphisms (SNPs).

recent years, a majority (63 percent) still consider that their inventories are incomplete.

3 Baseline surveys and monitoring of population sizes

This subsection focuses on activities undertaken in order to obtain data on the size and structure of national breed populations. The term "baseline survey" is used to refer to an initial data-gathering exercise that provides sufficient data to allow a breed population's risk status to be assessed accurately; ongoing activities that provide the data needed to track a breed's risk status over time are referred to as "monitoring" (FAO, 2011b). The state of implementation of surveying and monitoring activities for the "big five" species, grouped by region and subregion, is presented in Table 3B1. Results broken down by species are presented in Tables 3B2 and 3B3.

The country-report data indicate that baseline surveys have been conducted for 53 percent of national breed populations belonging to the big five species; 44 percent of national breed populations are monitored regularly. It is important to note here that the world figures are greatly influenced (in a positive direction) by those from

TABLE 3B1

Coverage of baseline surveys and monitoring programmes for the big five species

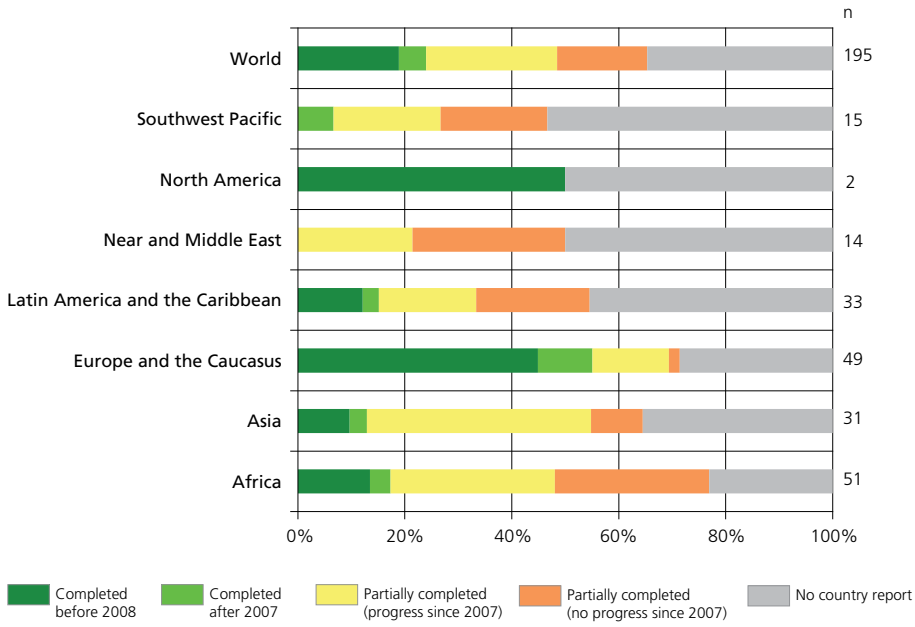
Regions and subregions	Number of countries	Number of national breed populations	Baseline survey of population size (%)	Regular monitoring of population size (%)
Africa	**40**	**1 317**	**45**	**23**
East Africa	8	289	62	22
North and West Africa	20	563	28	12
Southern Africa	12	465	54	36
Asia	**20**	**1 323**	**37**	**18**
Central Asia	4	165	83	38
East Asia	4	548	21	8
South Asia	6	276	50	9
Southeast Asia	6	334	31	31
Southwest Pacific	**7**	**216**	**30**	**16**
Europe and the Caucasus	**35**	**4 090**	**68**	**64**
Latin America and the Caribbean	**18**	**1 164**	**29**	**23**
Caribbean	5	142	42	35
Central America	5	324	33	32
South America	8	698	24	16
North America	**1**	**241**	**92**	**92**
Near and Middle East	**7**	**168**	**34**	**23**
World	**128**	**8 519**	**53**	**44**

Note: The number of national breed populations refers to the number reported in the country reports.
Big five species = cattle, sheep, goats, pigs and chickens.
Source: Country reports, 2014.

the Europe and the Caucasus region, which accounts for a large proportion (48 percent) of the total number of reported national breed populations in the big five species. In this region, the majority (64 percent) of national breed populations (all figures refer to the big five species) are monitored regularly. However, a substantial proportion of national breed populations (32 percent) have not been subject even to a baseline survey. The coverage of both baseline surveys and monitoring programmes is high (92 percent coverage) in North America. Elsewhere in the world, a few subregions – East Africa, Southern Africa and Central Asia – have a relatively high proportion (more than 50 percent) of national breed populations that have been subject to baseline surveys, but the overall figures for developing regions are low. The coverage of monitoring programmes also varies from subregrion to subregion: relatively high (more than 30 percent) in Southern Africa, Central Asia, Southeast Asia, the Caribbean and Central America, but low or very low elsewhere.

Country-report responses on the state of implementation of the Global Plan of Action show that approximately 45 percent of countries consider that they have fully implemented baseline surveys for breeds in all livestock species of economic importance. In contrast, almost 20 percent

FIGURE 3B1
Progress in the establishment of national breed inventories



Note: Countries were asked the following question: Which of the following options best describes your country's progress in building an inventory of its animal genetic resources covering all livestock species of economic importance? Response options were as follows: a. Completed before the adoption of the GPA; b. Completed after the adoption of the GPA; c. Partially completed (further progress since the adoption of the GPA); d. Partially completed (no further progress since the adoption of the GPA). The following definition was provided: "An inventory is a complete list of all the different breeds present in a country." GPA = Global Plan of Action for Animal Genetic Resources; n = number of countries.
Source: Country reports, 2014.

of countries report that no baseline surveys at all have been undertaken in any of their national breed populations. The remaining countries report partial coverage. In the case of monitoring programmes, 30 percent of countries report full coverage of breeds in all important livestock species, 30 percent report partial coverage and 40 percent report that they have no monitoring activities. Progress since the adoption of the Global Plan of Action has been encouraging, but unspectacular, overall. About 20 percent of countries report that the coverage of their monitoring programmes has increased since 2007. Approximately 30 percent report at least some new baseline surveys.

With regard to the state of organizational arrangements for monitoring programmes, almost 60 percent of countries report that they have allocated institutional responsibilities for monitoring programmes and about 35 percent that they have established protocols (details of schedules, objectives and methods) for such programmes.

4 Phenotypic and molecular genetic characterization

The level of implementation of various types of phenotypic and molecular genetic characterization study in the big five species is summarized in

TABLE 3B2
Coverage of baseline surveys and monitoring programmes for cattle

Regions and subregions	Dairy cattle			Beef cattle			Multipurpose cattle		
	Number of national breed populations	Baseline survey (%)	Monitoring (%)	Number of national breed populations	Baseline survey (%)	Monitoring (%)	Number of national breed populations	Baseline survey (%)	Monitoring (%)
Africa	**149**	**42**	**23**	**208**	**45**	**36**	**176**	**60**	**23**
East Africa	34	41	21	19	53	21	73	63	16
North and West Africa	67	28	18	79	23	11	66	45	18
Southern Africa	48	63	33	110	59	56	37	78	43
Asia	**68**	**54**	**37**	**119**	**40**	**29**	**142**	**36**	**8**
Central Asia	16	94	69	17	94	47	10	60	40
East Asia	10	90	70	27	48	30	60	7	0
South Asia	21	43	10	2	50	50	55	69	11
Southeast Asia	21	19	24	73	25	23	17	18	6
Southwest Pacific	**13**	**31**	**23**	**33**	**18**	**15**	**11**	**36**	**36**
Europe and the Caucasus	**206**	**86**	**80**	**425**	**84**	**85**	**219**	**82**	**80**
Latin America and the Caribbean	**103**	**35**	**31**	**247**	**40**	**34**	**65**	**31**	**23**
Caribbean	17	35	18	15	27	27	14	36	36
Central America	37	30	30	74	46	46	26	31	31
South America	49	39	37	158	39	30	25	28	8
North America	**15**	**73**	**73**	**59**	**93**	**93**	**4**	**100**	**100**
Near and Middle East	**19**	**47**	**26**	**7**	**14**	**14**	**19**	**37**	**32**
World	**573**	**59**	**48**	**1098**	**60**	**56**	**636**	**58**	**40**

Source: Country reports, 2014.

Figure 3B2 and Table 3B4. Because it was likely to be difficult for countries to provide precise information on the number of breed populations subject to specific types of study, the country-report questionnaire requested them to score the level of coverage, as follows: high (approximately >67 percent of breeds); medium (approximately 33 to 67 percent of breeds); low (approximately <33 percent of breeds); or none (no coverage). Figure 3B2 shows the proportion of answers falling into each category, broken down on the left by species and on the right by region. Table 3B4 presents a summary of the same data based on the average level of implementation at regional level.

Given that countries were not asked to provide precise breedwise data, the presentations do not reveal the exact proportion of breeds at global and regional levels subject to each type of study. There was clearly also some scope for differential interpretation of how much characterization work is necessary to qualify a breed as "characterized" as opposed to "non-characterized" under the scoring system. Moreover, it is possible that in some countries the

TABLE 3B3

Coverage of baseline surveys and monitoring programmes for sheep, goats, pigs and chickens

Regions and subregions	Sheep			Goats			Pigs			Chickens		
	Number of national breed populations	Baseline survey (%)	Monitoring (%)	Number of national breed populations	Baseline survey (%)	Monitoring (%)	Number of national breed populations	Baseline survey (%)	Monitoring (%)	Number of national breed populations	Baseline survey (%)	Monitoring (%)
Africa	**178**	**54**	**28**	**170**	**51**	**25**	**143**	**36**	**16**	**293**	**31**	**11**
East Africa	44	64	32	45	69	29	20	90	40	54	61	11
North and West Africa	73	41	15	65	37	17	69	25	7	144	13	5
Southern Africa	61	64	39	60	53	30	54	31	19	95	43	21
Asia	**224**	**58**	**15**	**189**	**37**	**15**	**194**	**25**	**15**	**387**	**29**	**19**
Central Asia	60	88	37	21	76	43	9	78	44	32	75	13
East Asia	75	31	1	78	18	5	114	18	10	184	18	7
South Asia	60	75	5	49	55	4	25	36	12	64	14	14
Southeast Asia	29	28	28	41	29	32	46	28	24	107	44	44
Southwest Pacific	**40**	**50**	**5**	**19**	**21**	**16**	**44**	**25**	**18**	**56**	**27**	**18**
Europe and the Caucasus	**957**	**80**	**80**	**327**	**81**	**76**	**334**	**89**	**84**	**1622**	**45**	**38**
Latin America and the Caribbean	**189**	**37**	**33**	**117**	**34**	**21**	**150**	**24**	**15**	**293**	**12**	**10**
Caribbean	24	50	46	22	45	41	26	38	31	24	50	38
Central America	42	26	26	35	34	34	36	33	31	74	24	24
South America	123	37	33	60	30	5	88	16	5	195	3	1
North America	**57**	**100**	**100**	**16**	**100**	**100**	**26**	**96**	**96**	**64**	**84**	**84**
Near and Middle East	**38**	**47**	**29**	**32**	**59**	**41**	**1**	**0**	**0**	**52**	**0**	**0**
World	**1683**	**85**	**72**	**870**	**73**	**55**	**892**	**65**	**54**	**2767**	**44**	**35**

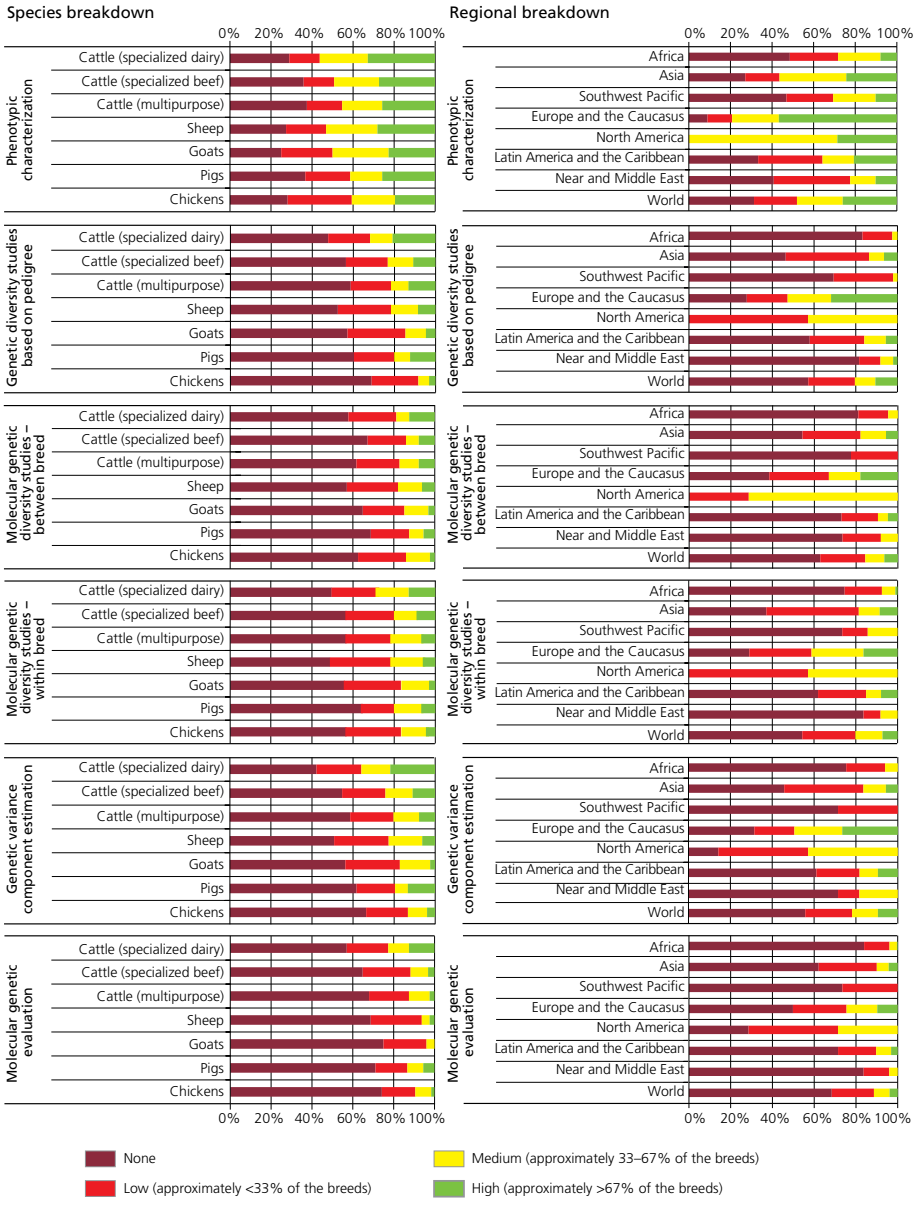
Source: Country reports, 2014.

reporting authorities were not aware of all relevant studies. Nonetheless, the country-level data appear to indicate many gaps in the coverage of characterization studies. For almost all combinations of species and type of study, a majority of countries report either no coverage or low coverage. Phenotypic characterization has been more widely implemented than the other activities. Across all categories, dairy cattle are more likely to have high or medium levels of coverage than other species (and other types of cattle). North America and Europe and the Caucasus, have higher levels of coverage than other regions, but many gaps in coverage remain even in these regions.

As noted in the introduction to this section, providing information on characterization activities targeting breeds other than the big five was not a compulsory element of the country-reporting process. Nevertheless, countries had the option of providing information on these species (equivalent to that provided for the big five). Results for buffaloes, horses, asses, dromedaries, rabbits,

FIGURE 3B2

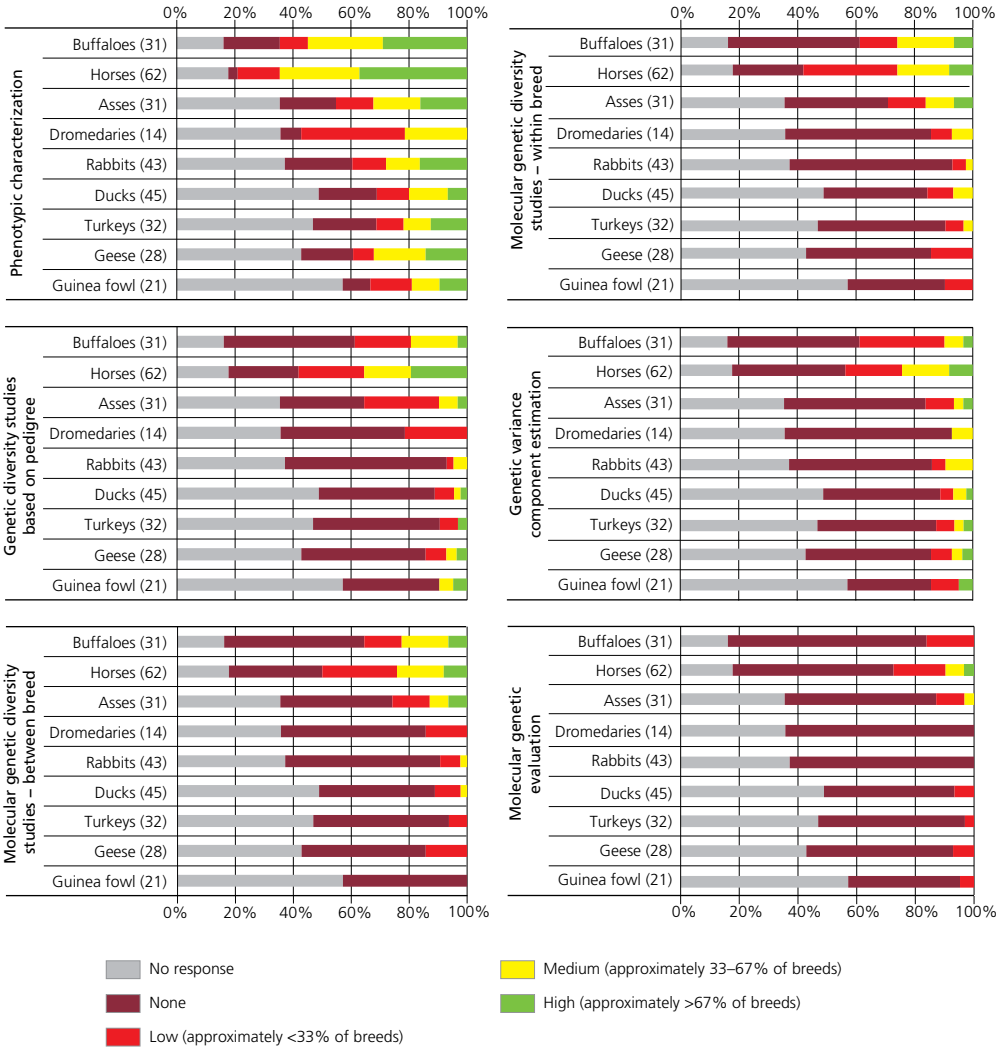
Characterization activities for the big five species – frequency of responses



Note: The bar charts show the proportion of responses falling into the none, low, medium and high categories of breed coverage (see legend). The charts on the left show the overall proportion of countries that provided the respective response for the respective species. The charts on the right show the proportion of answers (country × species combinations) from the respective region falling into the respective category.
Source: Country reports, 2014.

FIGURE 3B3

Characterization activities for "minor" species



Note: The figures refer only to countries that reported the presence of the respective species (number shown in brackets on the left for each species). The bars show the proportion of countries whose responses fell into the none, low, high and medium categories or that provided no information on the state of characterization in respective species.
Source: Country reports, 2014.

TABLE 3B4

Characterization activities for the big five species – average scores

Activity	Species	Africa	Asia	Southwest Pacific	Europe and the Caucasus	Latin America and the Caribbean	North America	Near and Middle East	World
Phenotypic characterization	Cattle (specialized dairy)								
	Cattle (specialized beef)								
	Cattle (multipurpose)								
	Sheep								
	Goats								
	Pigs								
	Chickens								
Genetic diversity studies based on pedigree	Cattle (specialized dairy)								
	Cattle (specialized beef)								
	Cattle (multipurpose)								
	Sheep								
	Goats								
	Pigs								
	Chickens								
Molecular genetic diversity studies – between breed	Cattle (specialized dairy)								
	Cattle (specialized beef)								
	Cattle (multipurpose)								
	Sheep								
	Goats								
	Pigs								
	Chickens								
Molecular genetic diversity studies – within breed	Cattle (specialized dairy)								
	Cattle (specialized beef)								
	Cattle (multipurpose)								
	Sheep								
	Goats								
	Pigs								
	Chickens								
Genetic variance component estimation	Cattle (specialized dairy)								
	Cattle (specialized beef)								
	Cattle (multipurpose)								
	Sheep								
	Goats								
	Pigs								
	Chickens								

(Cont.)

TABLE 3B4 *(Cont.)*

Characterization activities for the big five species – average scores

Activity	Species	Africa	Asia	Southwest Pacific	Europe and the Caucasus	Latin America and the Caribbean	North America	Near and Middle East	World
Molecular genetic evaluation	Cattle (specialized dairy)								
	Cattle (specialized beef)								
	Cattle (multipurpose)								
	Sheep								
	Goats								
	Pigs								
	Chickens								

0–0.5	0.5–1	1–1.5	1.5–2	2–2.5	2.5–3
Low		Medium		High	

Note: Scores provided by countries were converted into numerical values (none = 0; low = 1; medium = 2; high = 3). The colours indicate average scores for the countries of the respective region, as shown in the legend (border values assigned to the higher class).
Source: Country reports, 2014.

ducks, turkeys, geese and guinea fowl are shown in Figure 3B3. As with Figure 3B2, the bar charts indicate the proportion of responses (equivalent here to the proportion of countries) corresponding to each level of implementation. As providing information was not obligatory, a number of countries that reported the presence of a given species provided no indication of the level of implementation of characterization studies. The bar charts, therefore, in contrast to those for the big five, include a "no answer" category. The figure shows that, as in the case of the big five species, many gaps remain in the coverage of characterization studies. Phenotypic characterization has, again, been relatively widely implemented. Across the range of different activities, characterization of horses, and with some exceptions buffaloes, is more advanced than that of the other species.

Country reporting on the implementation of the Global Plan of Action indicates that many countries have made progress in AnGR characterization since 2007. In the case of both phenotypic and molecular genetic characterization, the majority of countries either report improvements or report that comprehensive studies had already been undertaken before 2007. Unfortunately, a substantial minority of countries remain at a low level of coverage and have not made any progress in recent years. Both the extent of coverage and the extent of progress are lower in the case of molecular genetic studies than in the case of phenotypic studies.

5 Constraints to characterization, surveying and monitoring

As noted above, the country-report questionnaire requested countries to provide information on the major barriers and obstacles preventing them from improving their inventory, characterization and monitoring programmes. Lack of funding was the most commonly mentioned constraint, followed by lack of human capacity (technical skills and knowledge). Other constraints mentioned included lack of infrastructure and technical resources (including for data management); lack of awareness on the part of policy-makers and livestock keepers; and lack of adequate policies and planning in the field

Box 3B2

China's second national animal genetic resources survey

China's first national survey of animal genetic resources began in 1976. The first phase was completed in 1984 and the results were published between 1986 and 1990. Another phase was implemented in 1995 and 1996, focusing on the southwestern mountainous area and Tibet, which had not been included in the first phase.

During the 1980s, China began to implement a reform and opening-up policy. The importation of exotic breeds and rapid development of intensive and large-scale production systems contributed to an unprecedented improvement in livestock production performances. However, these achievements were accompanied by a great threat to the diversity of China's animal genetic resources. As a result, the Ministry of Agriculture decided to carry out a second national survey. In 2003, the National Commission of Animal Genetic Resources organized experts to draft a technical manual in preparation for the second survey. The following year, four provinces were selected for a pilot survey. After two years of the pilot survey, the Implementation Plan for the National Survey on Animal Genetic Resources was finalized. In 2006, the plan was issued to provinces and regions nationwide by the Ministry of Agriculture, thereby formally launching the second survey.

It is estimated that more than 6 900 people from 30 provinces and autonomous regions nationwide were involved in the survey, with more than 45 million Yuan (approximately US$7.3 million) of central and local funds invested in the survey and the compilation of the findings. More than 1 200 animal breeds were surveyed and 21 300 photos of breeds were taken.

In 2010–2012, *The record of China's animal genetic resources* was finalized and published, based on the survey results. The publication consists of seven volumes and includes more than 2 100 pictures. A volume on bees and a volume on rabbits, deer and fur animals were published for the first time.

As a result of the survey, a number of previously unrecorded breeds were discovered and identified. These included breeds with distinctive characteristics, such as the Gaoligongshan pig and Piao chicken of the remote southwestern mountainous area. More than 540 indigenous breeds were described, more than twice the number recorded in the first survey.

The second survey revealed the precarious status of China's animal genetic resources. Nearly 300 indigenous breeds had declined in numbers, accounting for more than half of all breeds. Fifteen breeds had become extinct. 55 were endangered and 22 were on the brink of extinction, with the latter two categories accounting for 14 percent of the total.

Impacts of the second survey on policies have included the following:

- Since 2012, the annual regular budgetary allocation for the conservation of breeds has increased from 32 million Yuan to 50 million Yuan (more than US$8 million).
- To date, one in three provinces has launched regular budgetary allocation for the conservation of breeds on provincial priority lists. The annual budget varies from 4 million Yuan to 7 million Yuan (US$0.6 – US$1.1 million).
- In 2012, the Ministry of Agriculture issued the Twelfth Five Year Plan on the Conservation and Sustainable Utilization of Animal Genetic Resources, which includes plans to establish a national dynamic monitoring and early warning system.
- In February 2014, the Ministry of Agriculture re-issued the priority list for conservation. The number of breeds on the list has risen to 159.

Provided by Hongjie Yang.

Box 3B3

BushaLive – a collaborative project to characterize the Busha cattle of the Balkans

The BushaLive project, funded under the Funding Strategy for the Implementation of the Global Plan of Action for Animal Genetic Resources, targets the autochthonous Busha cattle breed of the Balkans, which survives in small, highly endangered, populations. The breed is hardy and well-suited to extensive farming, but has relatively low production yields. It is an important part of the local identity, but will be lost if conservation measures are not put in place to protect it. Stakeholders across the various nationalities and religions present in the Balkans share a common willingness to collaborate in conserving the breed.

Blood samples have been taken from 254 animals. The aim is to obtain unbiased estimates of diversity parameters, population history and the degree of admixture in the Busha population, using genome-wide marker data. Eight reference populations have been included. These represent possible sources of admixture and have also been subject to different levels of artificial selection. Four Busha strains sampled in former studies have also been included. These samples complement the newly collected material. Final conclusions will only be possible after completion of all the analyses. However, the results obtained so far show that locally well-adapted strains that have never been intensively managed and differentiated into standardized breeds show large haplotype diversity. This suggests the need for a conservation and recovery strategy that does not rely exclusively on searching for the original native genetic background, but rather on the identification and removal of common introgressed haplotypes.

Further information on each of the sampled animals has been collected via a comprehensive survey targeting their phenotypic characteristics and husbandry systems, as well as the products and services that they provide. This information, together with the genetic data, will be used to provide a basis for the development of a regional strategy for the management of the breed, spanning all stakeholder levels from farmers to governments. The project will also explore the potential for more effective marketing of the breeds' products. The next steps will be the establishment of basic recording systems and support for the development of breeding organizations and common breeding goals. The project will close with a stakeholder workshop for people working at all levels on the conservation of the breed. The event will provide an opportunity to pass on the information gathered and the strategies developed during the project to those who will use them in the future.

Provided by Elli Broxham, SAVE Foundation.

Photo credit: Elli Broxham.

Photo credit: Elli Broxham.

of characterization, surveying and monitoring. Some countries mentioned practical difficulties associated with the large size of the country or the location of livestock in remote areas, on small farms or in mobile production systems. A few countries mentioned problems associated with a lack of coordination – or a lack of willingness to share information – among stakeholders (e.g. breeders' associations and private companies).

6 Conclusions and priorities

The results presented above need to be treated with some caution because of possible missing data, and inter-country variations in interpretation of the scoring systems and the use of breed concept. Nonetheless, it is clear that in most regions of the world there are major gaps in the coverage of characterization activities and hence major gaps in knowledge about the characteristics of AnGR. Similarly, there are major gaps in programmes for monitoring trends in the size and structure of breed populations and hence the current risk status of many breeds is unknown. These gaps in knowledge inevitably hamper the sustainable use, development and conservation of AnGR. Weaknesses are particularly marked in the developing regions of the world. Research priorities in the field of characterization are discussed in Part 4 Sections A and B.

Strategic priorities for improving the state of inventory, characterization and monitoring are set out in the Global Plan of Action, which recognizes the fundamental importance of improving the state of knowledge of AnGR. Many countries have made some progress in implementing these priorities. However, progress is often constrained by a lack of human and financial resources. The need to strengthen capacity in this field is recognized in the Global Plan of Action as follows:

> *"Establish or strengthen, in partnership with other countries, as appropriate, relevant research, training and extension institutions, including national and regional agricultural research systems, to support efforts to characterize, inventory and monitor trends and associated risks, sustainably use and develop, and conserve animal genetic resources".*[1]

The evidence from the country reports suggests that this recommendation remains highly relevant.

Lack of funding is a widespread constraint to improving many aspects of the management of AnGR. The Global Plan of Action recognizes both the need for "substantial and additional financial resources" and the need for predictable allocation of such resources. The latter may be particularly significant for ongoing activities such as monitoring programmes. Unfortunately, the country reports indicate that improving funding is one of the elements of the Global Plan of Action for which least progress has been made to date (FAO, 2014a) (see Table 3F2 in Part 3 Section F).

While monitoring programmes are far from comprehensive in terms of breed coverage, in most species a majority of national populations are reported to be subject to regular population monitoring. Here there appears to be a discrepancy with the level of reporting of breed population data at international level, i.e. the entry by countries of their national data into the Domestic Animal Diversity Information System (DAD-IS) (see Part 1 Section B). For example, 78 percent of national breed population figures in DAD-IS were not updated once during the four years preceding the preparation of this report (FAO, 2014b). If data are available at national level, it is important that they are entered into DAD-IS so that global trends can be monitored more effectively.

Another issue that may require attention is the institutional framework for the surveying and monitoring of AnGR. The Global Plan of Action recognizes the need to "encourage the establishment of institutional responsibilities and infrastructure for monitoring of trends ..." Establishing an effective surveying and monitoring programme requires not only funds and human resources, but also clear allocation of responsibilities for overall

[1] Strategic Priority 13, Action 3.

coordination and for specific tasks (organization of surveys, provision of data to national authorities, etc.). Objectives, relevant to national data requirements and feasible in terms of national capacities, need to be defined and support from stakeholders needs to be ensured. The country reports indicate that some progress has been made in terms of improving institutional arrangements for surveying and monitoring, but that large gaps remain. Advice on the development of national strategies in this field, including institutional arrangements and stakeholder involvement, is provided in the FAO guidelines *Surveying and monitoring of animal genetic resources* (FAO, 2011b). The guidelines *Phenotypic characterization of animal genetic resources* and *Molecular genetic characterization of animal genetic resources* (FAO, 2011a; 2012) also provide advice on how to ensure that characterization studies are relevant to national requirements. All three guidelines provide practical advice on the organization of characterization and monitoring activities.

The country reports reveal gaps in implementation across all the activities discussed in this section. Specific priorities for action will depend on national circumstances. However, in many countries the basic task of establishing a full inventory of national breeds has not been completed. Similarly, for many recognized breeds, phenotypic characteristics – morphology, performance in specific production environments, degree of adaptedness to specific diseases or climatic challenges, and so on – have been inadequately studied. Gaps are particularly prominent in developing countries, which means that the characteristics of the locally adapted breeds of these countries have been poorly characterized and that the comparative performance of different breeds in the production conditions of these countries has been inadequately assessed. If these gaps are not addressed, it will be difficult or impossible to manage locally adapted breeds sustainably and ensure that their potential is realized.

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