

FAO ANIMAL PRODUCTION AND HEALTH



guidelines

PHENOTYPIC CHARACTERIZATION OF ANIMAL GENETIC RESOURCES

COMMISSION ON
GENETIC RESOURCES
FOR FOOD AND
AGRICULTURE



FAO ANIMAL PRODUCTION AND HEALTH

PHENOTYPIC
CHARACTERIZATION OF
ANIMAL GENETIC RESOURCES



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Abbreviations and acronyms

ACSAD	Arab Center for Studies of Arid Zones and Dry Areas
AnGR	animal genetic resources for food and agriculture
AOAD	Arab Organization for Agricultural Development
DAD-IS	Domestic Animal Diversity Information System
DNA	deoxyribonucleic acid
FABISNet	Farm Animal Biodiversity Information System Network
FPC	finite population correction
GPS	global positioning system
ICARDA	International Center for Agricultural Research in the Dry Areas
IFAD	International Fund for Agricultural Development
IICA	Inter-American Institute for Cooperation on Agriculture
ILRI	International Livestock Research Institute
ISAG	International Society for Animal Genetics
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OTU	operational taxonomic unit
PED	production environment descriptor
SADC	Southern Africa Development Community
SAHN	sequential, agglomerative, hierarchic and non-overlapping
SPC	Secretariat of the Pacific Community
STT	Thin-tailed sheep of Sumatra
WB	World Bank

Acknowledgments

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Preamble

These guidelines are part of a series of publications produced by FAO to support countries in the implementation of the *Global Plan of Action for Animal Genetic Resources*. While each of these publications addresses a different aspect of the management of animal genetic resources for food and agriculture (AnGR), they should be utilized in conjunction. The guidelines on phenotypic characterization fall within Strategic Priority Area 1 of the *Global Plan of Action*, which is also being addressed by two other guideline publications: one focusing on surveying and monitoring of AnGR and the other on molecular characterization. The guidelines on surveying and monitoring (FAO, 2011a) present the “big picture” – describing how to plan a national strategy for obtaining AnGR-related data and keeping them up to date; they introduce the various types of survey that may form part of such a strategy, and outline the main steps involved in planning and implementing a survey. The guidelines on phenotypic characterization describe how to conduct a study on a specific animal population and its production environment – including details of what to measure, how to take these measurements and how to interpret them. The guidelines on molecular characterization (FAO, 2011b) provide advice on how to obtain and use DNA samples to support the management of AnGR. Despite these differences in focus, there is inevitably some overlap in the subject matter of the three publications.

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Introduction

RATIONALE

Characterization of animal genetic resources for food and agriculture (AnGR) involves three types of information: phenotypic, genetic and historical. The weight given to each depends on the country (e.g. whether it is developed or developing) and the objective (e.g. improvement, conservation or breed differentiation). These guidelines focus on the collection and use of phenotypic information.

Phenotypic characterization of AnGR is the process of identifying distinct breed populations and describing their external and production characteristics in a given environment and under given management, taking into account the social and economic factors that affect them. The information provided by characterization studies is essential for planning the management of AnGR at local, national, regional and global levels. The *Global Plan of Action for Animal Genetic Resources* (FAO, 2007) recognizes that “A good understanding of breed characteristics is necessary to guide decision-making in livestock development and breeding programmes”. The *Global Plan of Action's* Strategic Priority Area 1 is devoted to “Characterization, Inventory and Monitoring of Trends and Associated Risks”.

Assessing the diversity of AnGR is made more difficult by the existence of many animal populations that are not assigned to any recognized breed. Even though parts of these “non-descript” populations are known to be multiple crosses of recognized breeds, some animals may belong to (relatively) homogenous groups distinguishable from neighbouring populations on the basis of identifiable and stable phenotypic characteristics (among which may be unique and valuable attributes) that warrant their being distinguished as separate breeds. Determining whether or not this is the case is one of the roles of phenotypic characterization and is a prerequisite for effective assessment of AnGR diversity and determining whether or not it is being eroded. Phenotypic characterization is therefore fundamental to the establishment of national inventories of AnGR, to effective monitoring of AnGR populations and to the establishment of early-warning and response systems for AnGR.

Phenotypic characterization activities are technically and logistically challenging. Ensuring that they are well targeted (collect data that are important to the country's priority AnGR- and livestock-development activities) and are carried out in an efficient and cost-effective manner requires thorough planning and careful implementation. Valid comparisons among livestock breeds or populations, whether nationally or internationally, require the development and use of standard practices and formats for describing their characteristics. Such standards and protocols are also needed for assessing requests for the recognition of new breeds. The *Global Plan of Action* calls for the development of “international technical standards and protocols for characterization, inventory, and monitoring of trends and associated risks” (Strategic Priority 2).

The main objectives of these guidelines are to provide advice on how to conduct a well-targeted and cost-effective phenotypic characterization study that contributes to the improvement of AnGR management within the context of country-level implementation of the *Global Plan of Action*, and to ensure that such studies provide a sound basis for international breed comparisons and for the preparation of global assessments of the status of AnGR.

BACKGROUND AND DEVELOPMENT OF THE GUIDELINES

The *Global Plan of Action for Animal Genetic Resources* calls on FAO to publish technical guidelines and provide assistance to countries in support of their efforts to improve the management of AnGR. As described in the preamble, these guidelines on phenotypic characterization are part of a series of guideline publications produced by FAO in response to this request. The Commission on Genetic Resources for Food and Agriculture, at its Twelfth Regular Session in 2009, endorsed the first guidelines in the series and “further requested FAO to continue updating and further developing other technical guidelines on the management of animal genetic resources as important support for countries in their implementation of the *Global Plan of Action*” (FAO, 2009a).

The guidelines build upon FAO’s earlier work on characterization, which was an important component of the organization’s technical programme of work on AnGR, the “Global Strategy for the Management of Farm Animal Genetic Resources” (FAO, 1999), the development of which began in 1993 and which has now been superseded by the *Global Plan of Action*. Even prior to the development of the Global Strategy, methods for characterization of AnGR had been described in several publications in the FAO Animal Production and Health Paper Series (e.g. FAO, 1984a,b; 1992). FAO published a comprehensive list of variables for describing the phenotypic and genetic characteristics of cattle, sheep, goats and chickens as the basis for systematic phenotypic characterization of these species (FAO, 1986a,b,c). It also developed the Domestic Animal Diversity Information System (DAD-IS) to serve as a global data repository and clearing-house facility to support countries in the management of their AnGR-related data and information and in meeting their obligations to report on the status of their national biodiversity within the framework of the Convention on Biological Diversity. The current guidelines are intended to provide practical advice on how to plan and implement phenotypic characterization projects. Draft versions of the guidelines were discussed and evaluated by 100 participants from 28 countries at three workshops, which were held in Argentina (December 2009), Senegal (March 2010) and Italy (June 2010).

USER GUIDANCE

Scope of the guidelines

The guidelines describe the whole process of organizing a phenotypic characterization study from the initial identification of objectives, through planning and implementation of field work, data management and analysis, to reporting the outputs of the study and promoting their full and effective use. Emphasis is given to the importance of collecting data both on the animals themselves and on their production environments; advice relevant to both these aspects of characterization work is included in all the sections of the guidelines.

The guidelines address both “primary” phenotypic characterization activities, which can be undertaken during a single visit and provide a basic picture of the state of AnGR diversity in the study area, and “advanced” characterization activities, which require repeated measurements over an extended period. Advice is provided on the decision as to whether primary or advanced characterization is needed in order to meet the objectives of the study and on how the former can lay the basis for the latter.

The guidelines focus mainly on the low to medium external input production environments of developing countries (where the gaps in AnGR-related knowledge are most substantial and where the “hotspots” of diversity loss are expected to be located in the coming decades). Many valuable traits in these populations probably remain unknown or undocumented. However, much of the activity described is also relevant for developed-country contexts and for high external input production systems, where characterization activities are mainly for the recognition of new breeds. Because of the financial implications of such recognition (e.g. the right to apply for subsidies), more stringent characterization procedures may be required in this context.

The guidelines address situations in which the populations targeted for characterization consist of non-descript animals (not distinguished into recognized breeds) and situations in which the objective is to enhance the state of knowledge of breeds that are already recognized.

The focus of the guidelines is mainly on the five livestock species that are most significant on a global scale – cattle, sheep, goats, chickens and pigs. However, the basic advice on how to plan and implement a survey is relevant to other livestock species. Furthermore, essentially the same key variables can be used to describe closely related animal species. For instance, the descriptors for cattle can be applied to the yak or the buffalo with minimum modifications. Similarly, other avian species can be described using the chicken descriptors.

Target audience

The main target audience for the guidelines comprises individuals involved in planning and implementing characterization studies. Such studies have generally been undertaken by researchers in public research institutions, students doing academic research, and the staff of livestock-development projects. Unfortunately, the outputs of these studies have often ended up gathering dust on book shelves. It is therefore important to emphasize that anyone considering undertaking a phenotypic characterization study should ensure that it addresses a specific “demand” for information. The ideal scenario is that the characterization study is an element within a coherent national strategy for improving knowledge of the country’s AnGR as a basis for meeting priority objectives for AnGR management and livestock development. Whatever the circumstances, the contribution of the proposed study to future AnGR management should be clearly thought out, and the potential users of the study outputs should be consulted.

The guidelines may also be useful to decision-makers who wish to obtain a better understanding of the potential contributions of phenotypic characterization studies to national policies and programmes for AnGR and of the practicalities involved in implementing such studies.

BOX 1

A breed improvement scheme based on insufficient characterization information – the case of Bolivian Criollo sheep

In the 1960s Bolivia had about 12 million Criollo sheep but limited knowledge of their potential except for some information related to their zoometric measures and appearance. These animals are a major component of Andean production systems – both mixed crop–livestock systems and grazing systems – and contribute to families' livelihoods through the production of meat, fibre, cheese, milk and manure. Herd sizes ranging from 40 to 60 head.

During the same decade, the Government of Bolivia and the University of Utah established a cooperation programme to investigate ways to improve Andean production systems. Based on poor documentation of the potential of the Criollo sheep, researchers concluded that its small size (average adult weight of 24 kg) and its poor wool production and quality (800 g/sheep/year) should be improved by crossing it with improved breeds. A programme of cross-breeding with Corriedale, Targhee and Rambouillet sheep originating from the United States of America was introduced and lasted until the mid-1980s.

Thirty years later, the highland sheep producer has never become a fine-wool producer. Some producers increased their wool production but, because of the small scale of production, this did not result in substantial increases in revenue. The size of the animals increased, and with it their demand for feed in an environment where feeding is dependent on degraded native pasture. In many cases, the fertility of the native Criollo sheep (> 90 percent) decreased, but lamb mortality remained high. Many producers "returned" to keeping a Criollo type, but of a larger size.

Bolivian researchers acknowledged that they had ignored both the productive potential of Criollo sheep and their particular characteristics (apart from their small size and weight and their "unappealing" appearance). Following this experience, characterization studies of the productive capacity of Criollo sheep under farm conditions, and of market demand, were conducted. They showed that some farmers received a steady income from the sale of sheep cheese made from the small amounts of milk collected from individual animals. There was also an important market demand for Criollo sheep meat, in particular in the main cities located in the country's highlands. Finally, peasants preferred the wool of Criollo sheep for manufacturing felt and for local crafts. None of these features were considered when establishing the breeding programme, which as a consequence did not meet the requirements of the producers.

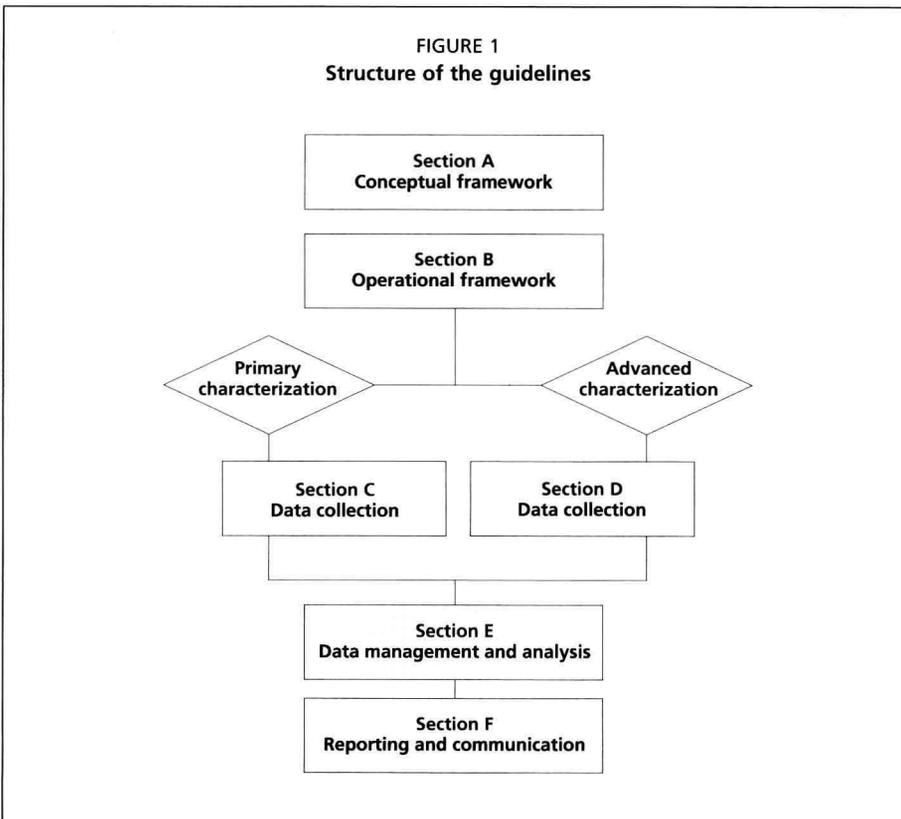
This example illustrates some of the consequences of an inadequately designed programme based on insufficient characterization of the target population.

Provided by Luis Iñiguez.

Structure of the guidelines

These guidelines contain six sections (Figure 1). Section A sets out the conceptual and theoretical background to the practical guidance presented in the other sections. It begins by discussing the meaning of the term “phenotypic characterization” along with the concepts of the “breed” and the “non-descript population”; it also addresses the significance of wild relatives of domesticated animals in phenotypic characterization studies. Broad approaches to phenotypic characterization (exploratory vs. confirmatory) are then distinguished. This is followed by an overview of principles and methods for breed identification and of the constituent elements of phenotypic characterization, including the description of production environments and economic valuation of non-production traits.

In Section B, the focus shifts to the preparatory activities for individual phenotypic characterization studies. Emphasis is given to the importance of linking such studies to the requirements of the country's national strategy and action plan for AnGR and (if applicable) national surveying and monitoring strategy. The tasks of constituting the study team, collecting background information and clarifying the objectives and scope of the study (including the fundamental distinction between primary and advanced characterization) are described. Sections C and D describe data collection activities. The former focuses on primary characterization and the latter on advanced characterization. Section E describes



data management (including checking data quality, data entry, data cleaning and processing, and data archiving) and data analysis (including a discussion of the resources required, statistical packages, critical steps in the process of analysis, and interpretation of results). Primary and advanced characterization are here described within a single section. Section F provides advice on reporting the results of the study and communicating them to relevant stakeholders.

The annexes to the guidelines provide check lists for the description of major livestock species and their production environments. These lists are intended as guides that can be adapted, as necessary, to match the objectives and circumstances of specific characterization studies.

The guidelines do not specify standards for quantitative and qualitative variables, data collection tools, precision in data recording or methods for managing and storing the data. Rather they describe options and approaches and provide users with advice on how to tailor them to fit their needs.

SECTION A

Conceptual framework

