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Factors and determinants of animal genetic resources management activities across the world

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ABSTRACT

This paper investigates the factors affecting the implementation of various management activities related to the characterization, use and conservation of animal genetic resources (AnGR) across countries. The 128 official country reports provided for *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture* were analysed based on a multivariate approach. These reports investigated topics related the national level of AnGR diversity, the extent of characterization activities, use and breeding programmes and conservation activities, as well as capacities in AnGR management and the use of biotechnologies related to livestock breeding. A large part of the variability (34.7%) of the dataset could be explained by one synthetic variable, which could be interpreted as the general extent of AnGR related activities, and indicate that country efforts on AnGR are directed relatively homogenously towards the various activities and species considered. This variable differentiated mainly OECD and BRICS countries from less developed ones. OECD and BRICS countries also appeared to be differentiated with respect to the use of some specific biotechnologies such as cloning, genetic modification and transplantation of gonadal tissues. With regards to economic and development indicators, the first synthetic variable showed large correlation with the number of researchers in agricultural sciences per inhabitant ($r=0.643$) and national GDP ($r=0.516$). Capacities in research therefore appeared to be one of the main enabling forces for activities related to AnGR and the implementation of the Global Plan of Action (GPA) for AnGR.

1. Introduction

Animal genetic resources (AnGR), corresponding to domestic livestock and poultry species, have an essential role in the maintenance and development of livestock production systems over the world. They are critical for insuring long-term food security and poverty alleviation, as the number of poor livestock keepers around the world is estimated around 750 million (FAO, 2012a).

In 1992, the Convention on Biological Diversity (CBD, 1992) established the responsibilities of countries with respect to the conservation of their genetic diversity, including its domesticated component. In 2007, the report on *The State of the World's Animal Genetic Resources for Food and Agriculture* (SoW) constituted a first global assessment of the status and trends of AnGR and their management (FAO, 2007a). Through the Interlaken Declaration, countries confirmed their common and individual responsibility for the conservation, sustainable use and development of AnGR (FAO, 2007b). They adopted, in response to the gaps and needs identified in the first SoW, the Global Plan of Action for Animal Genetic Resources (GPA), a framework featuring 23 Strategic Priorities (SP) grouped into four Strategic Priority Areas (SPA): Characterization, Inventory and Monitoring of Trends and Associated Risks (SPA 1); Sustainable Use and Development (SPA 2); Conservation (SPA 3); and Policies, Institutions and Capacity-building (SPA 4). The GPA includes lists of actions for each SP.

The SoW, which was based on information provided by 169 countries, showed large discrepancies between countries in terms of the state and management of AnGR: breeds and species are not equally present across all regions; breeding activities (animal identification, genetic evaluation, etc.), as well as the use of reproductive and molecular biotechnologies (artificial insemination, genetic modification, etc.), are not implemented at the same level; similarly, characterization and conservation activities differ greatly between countries. These differences may be explained by a range of factors, including the general level of economic and agricultural development, or have sociocultural causes.

In order to assess the changes in the general state of capacities in AnGR management since the publication of the SoW (FAO,

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Table 1
Variables used from the Country Reports received for the Second Report on the State of the World's Animal Genetic Resources, grouped by topic and respective section.

Topic	Section[1]	Variables	By species	Number of variables
Diversity	II	Number of breeds reported by countries (by species) ratio of number of exotic breeds to total number of breeds	yes	9
Characterization	II	Extent of characterization activities, based on proportion of breeds with activities implemented, estimated or approximated (by species)	yes	56
	IV	Level of progress in GPA strategic priorities relative to Strategic Priority Area (SPA) 1 (characterization) of the Global Plan of Action for Animal Genetic Resources	no	2
Use and breeding	II	Proportion of breeds with specific activities undertaken (by species)	yes	56
	IV	Level of progress in GPA strategic priorities relative to SPA2 (sustainable use)	no	4
Conservation	II	Extent of coverage of in situ, *ex situ* in vivo, *ex situ* in vitro conservation activities areas (n/a, none, low, medium, high) (by species)	yes	21
	IV	Level of progress in GPA strategic priorities relative to SPA3 (conservation)	no	3
Capacities	II	Extent of country capacity and provisions estimated in different areas of animal genetic resources (none, low, medium, high)	no	10
	IV	Level of progress in GPA strategic priorities relative to SPA4 (Policies, Institutions and Capacity-building)	no	5
Biotechnologies	II	Level of availability of reproductive and molecular biotechnologies (none, low, medium, high) (by species)	yes	63

[1]Section II. Data on AnGR and activities for their management (FAO, 2007); Section IV. Status in the implementation of the Global Plan of Action for Animal Genetic Resources – 2007–2013.

2007a) and the adoption of the GPA in 2007, FAO recently prepared *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture* (SoW2). To collect the information necessary for this assessment, FAO, in 2013, invited all countries worldwide to submit country reports, using a standardized questionnaire.

In general, the information provided in the country reports was either quantitative (count data or subjective ordinal ratings) or qualitative (narrative descriptions or explanations). In total, 128 official country reports (66% of countries) were received, the reduction in comparison to first SoW being related, among other things, 30 from OECD countries and 98 from non-OECD countries, including the 5 BRICS (Brazil, the Russian Federation, India, China and South Africa). The analysis of the country reports revealed wide variation across countries in terms of AnGR management (FAO, 2015a) and in terms of the level of implementation of the Global Plan of Action (FAO, 2014). Despite considerable achievements in policy development, technical developments such as the characterization, use and conservation of the world's AnGR remain far from complete, especially in developing countries. Limited financial resources, lack of policy/legal framework implementation, and lack of institutional and human capacity were frequently listed in the country reports as important constraints to progress in AnGR management and GPA implementation. These findings are in agreement with existing literature (Zonabend et al., 2013; Chagunda et al., 2015).

Country response rate to United Nations global assessments is usually low (United Nations Statistics Division, 2007; WHO, 2008; Lesnikowski et al., 2013). The high return of country reports for the two global AnGR assessments is, in itself, a measure of success and an indication of high interest and engagement in the topic. This may be because a diverse portfolio of livestock breeds is vital to food security and enables food systems to adapt to changing conditions and country decision-makers are increasingly concerned about the sustainability of their national agriculture and food systems. The maintenance of breed diversity is not only a goal of the GPA, but also of the Convention on Biological Diversity's Aichi Target 13 and of Sustainable Development Goal (SDG) Target 2.5.

The information provided in the country reports, for example all Likert-scale answers, is partially subjective, as it reflects the judgement of the national coordinators and advisory committees who completed the questionnaires. To our knowledge, such "soft" information provided in country reports for a United Nation consultation process has so far mostly been analysed descriptively, and only "hard" statistical data used for statistical analysis.

In this study, we performed a quantitative analysis of the country report data, using multivariate approaches. Among others things, we sought to find patterns of differentiation among countries in terms of the current state of AnGR and actions improving their management. Another aim of the study was to answer various questions on the factors associated with the degree of implementation of AnGR management activities, such as (i) how the economic situation determines the extent of AnGR activities, (ii) whether efforts in AnGR management are directed toward all species and activities equally and (iii) whether all available technologies are used in AnGR management..

2. Material and methods

2.1. Material studied

Data were extracted from the 128 country reports, specifically from quantitative responses provided in Sections II and IV of the reports (the two other sections provided an executive summary and information contributing to another global assessment). The questionnaires included explanations and definitions for all terms to ensure that responses were as consistent as possible (for access to questionnaires, see http://www.fao.org/3/a-i4787e/i4787e01.htm). Section II addressed the state of AnGR within each country and the state of programmes and capacity for their management. Section IV provided information specifically on national implementation of various aspects of the GPA. The Section II questions selected for analysis (Table 1) addressed the following six topics: 1) AnGR diversity; 2) characterization; 3) breeding programmes; 4) conservation programmes; 5) capacities in AnGR management; and 6) use of biotechnologies.

The country report questions on AnGR diversity included those seeking information on the numbers of breeds reported for the "big five" species: cattle (separately for dairy cattle, beef cattle and multipurpose cattle), sheep, goats, pigs and chickens; the number of breeds reported for other species; and the ratio between the number of exotic breeds and the total number of breeds reported for all species. The questions related to characterization addressed the extent of characterization activities such as baseline surveys, regular monitoring, phenotypic characterization, and pedigree or molecular genetic diversity studies. Questions on breeding