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Editorial

2010 has been declared the International Year of Biodiversity by the United Nations. The year is being marked by many events and publications that celebrate biodiversity and promote awareness of the role that it plays in sustaining life on Earth and contributing to human livelihoods and cultures around the world. Animal Genetic Resources Journal is delighted be publishing this special edition as a contribution to the year's events and as a means of promoting the sustainable management of biodiversity in the livestock sector.

2010 also marks three years since the adoption of the *Global Plan of Action for Animal Genetic Resources*[1] – the first internationally agreed framework for the management of animal genetic resources (AnGR). It is an opportune time to begin assessing whether the enthusiasm and momentum generated by the adoption of the *Global Plan of Action* and the reporting activities that preceded it are starting to bear fruit. The first paper in this edition, therefore, presents an overview of progress made to date, with a focus on implementation of the *Global Plan of Action* at national level. The other 12 invited papers span the four strategic priority areas of the *Global Plan of Action*.

Strategic Priority Area 1 – "Characterization, inventory and monitoring of trends and associated risks" – is represented by three papers. The first addresses the task of identifying and analysing threats to the survival of AnGR diversity. The second describes the role of surveys as a means of obtaining AnGR-related data that can provide a basis for improved management these resources. The third, reviews efforts that have been made to develop indicators of the status and trends of genetic diversity in domestic animals.

Strategic Priority Area 2 – "Sustainable use and development" – is represented by two papers. The first presents the results of a project that investigated farmers' motives and values with regard to the keeping of local breeds of cattle in Europe. The second paper discusses the marketing of products from local breeds of livestock, drawing on an analysis of case studies in Africa, Asia and Latin America.

Strategic Priority Area 3 – "Conservation"– is represented by five papers, the first of which provides an overview of the state of national programmes for the conservation of AnGR. The second paper reviews the potential contributions of economic decision-support tools and analytical approaches to AnGR conservation programmes, and the extent to which they have been used in "real-world" situations. The third paper reviews options and legal requirements related to the development of national and regional gene banks for AnGR, while the fourth paper considers the role of protected areas in AnGR conservation. The final paper addressing this strategic priority area considers the conservation status of the wild relatives of domestic animals.

Strategic Priority Area 4 – "Policies, institutions and capacity-building" – is represented by two papers. The first discusses the state of discussions related to the concept of livestock keepers' rights, and the second describes the contribution that networking has made to the management of AnGR in Europe.

While it is very heartening to read of the various first-steps that countries have taken in the implementation of the *Global Plan of Action*, as described in the first paper of this edition, a full picture of the state of implementation will only emerge once the first round in the formal process of evaluating progress in the implementation of the *Global Plan of Action* has been successfully completed. Therefore, it is essential that in 2011, as requested by the Commission on Genetic Resources for Food and Agriculture, all countries prepare progress reports on their national activities in implementing the *Global Plan of Action*, so that FAO can prepare a synthesis report for consideration by the Commission.

Many of the papers in this edition indicate that while progress has been made, many gaps and weaknesses remain in our knowledge of AnGR and in the tools that are available for studying and managing these resources. Likewise, while programmes and policies AnGR management are gradually being developed and strengthened, and levels of awareness of AnGR-related issues are gradually being improved, many obstacles need to be overcome before the sustainable use, development and conservation of the world's AnGR can be assured. We would therefore like to appeal to the readership of this journal – whether researchers, people working for governmental or non-governmental organizations, livestock keepers or concerned members of the general public – to promote and contribute to the implementation of the *Global Plan of Action*.

[1] *www.fao.org/docrep/010/a1404e/a1404e00.htm*

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Editorial

Les Nations Unies ont déclaré 2010 l'Année internationale de la biodiversité. Cette année est marquée par de nombreux événements et de nombreuses publications qui célèbrent la biodiversité et favorisent la sensibilisation sur le rôle qu'elle joue dans le maintien de la vie sur Terre et dans sa contribution aux moyens d'existence et aux cultures des hommes dans le monde entier. La rédaction du journal Ressources génétiques animales a le plaisir de publier ce numéro spécial pour apporter sa contribution aux célébrations de cette année et pour promouvoir la gestion durable de la biodiversité dans le secteur de l'élevage.

En 2010, on célèbre également le troisième anniversaire de l'adoption du *Plan d'action mondial pour les ressources zoogénétiques*[1] – le premier cadre convenu au niveau international pour la gestion des ressources zoogénétiques. Le moment est venu d'entreprendre une évaluation pour comprendre si l'enthousiasme et l'élan créés par l'adoption du *Plan d'action mondial* et les activités d'établissement de rapports qui l'ont précédée commencent à donner leurs fruits. Par conséquent, le premier article de ce numéro expose une vue d'ensemble des progrès accomplis jusqu'à présent, en se concentrant en particulier sur la mise en œuvre du *Plan d'action mondial* au niveau national. Les 12 autres articles s'étendent sur les quatre domaines prioritaires du *Plan d'action mondial.*

Le domaine prioritaire 1 – «Caractérisation, inventaire et surveillance des tendances et des risques associés» – est représenté par trois articles. Le premier article aborde la tâche concernant l'identification et l'analyse des menaces à la survie de la diversité des ressources zoogénétiques. Le deuxième décrit le rôle des enquêtes en tant que moyen permettant d'obtenir des données relatives aux ressources zoogénétiques qui pourraient servir de base pour l'amélioration de la gestion de ces ressources. Le troisième article examine les efforts mis en place pour mettre au point des indicateurs de l'état et des tendances de la diversité génétique chez les animaux domestiques.

Le domaine prioritaire 2 – «Utilisation durable et mise en valeur» – est représenté par deux articles. Le premier présente les résultats d'un projet qui a étudié les motivations et les valeurs des agriculteurs en ce qui concerne l'élevage des races locales de bovins en Europe. L'autre article traite de la commercialisation des produits provenant des races locales d'animaux d'élevage, puisant de l'analyse de quelques études de cas en Afrique, en Asie et en Amérique latine.

Le domaine prioritaire 3 – «Conservation» – est représenté par cinq articles, dont le premier fournit une vue d'ensemble de l'état des programmes nationaux en faveur de la conservation des ressources zoogénétiques. Le deuxième article analyse les contributions potentielles des outils d'aide à la prise de décisions économiques et des approches analytiques aux programmes de conservation des ressources zoogénétiques, et la portée à laquelle ils ont été utilisés dans la réalité. Le troisième article examine les options et les prescriptions légales associées à la mise en place des banques de gènes nationales et régionales pour les ressources zoogénétiques, tandis que le quatrième étudie le rôle des zones protégées dans la conservation des ressources zoogénétiques. Le dernier article sur le domaine prioritaire 3 traite de l'état de la conservation des parents sauvages des animaux domestiques.

Le domaine prioritaire 4 – «Politiques, institutions et renforcement des capacités» – est représenté par deux articles. Le premier article aborde l'état des débats relatifs au concept des droits des éleveurs et le second décrit la contribution de la mise en réseau à la gestion des ressources zoogénétiques en Europe.

Bien qu'il soit très encourageant de lire des différentes premières étapes, décrites dans le premier article de ce numéro, que les pays ont entreprises dans la mise en œuvre du *Plan d'action mondial*, le tableau réel de son état de mise en œuvre ne sera complet qu'une fois terminée avec succès la première partie du processus formel d'évaluation des progrès accomplis. Par conséquent, il est essentiel qu'en 2011, tel que requis par la Commission des ressources génétiques pour l'alimentation et l'agriculture, tous les pays préparent les rapports d'avancement relatifs aux activités nationales de mise en œuvre du *Plan d'action mondial* pour que la FAO puisse élaborer un rapport de synthèse à soumettre à la Commission.

Bon nombre d'articles de ce numéro indiquent que, tout en reconnaissant les progrès accomplis, de nombreuses lacunes et faiblesses sont encore présentes dans notre connaissance des ressources zoogénétiques et dans les outils qui sont disponibles pour l'étude et pour la gestion de ces ressources. En outre, malgré le développement et le renforcement graduels des programmes et des politiques en matière de gestion des ressources zoogénétiques, et l'amélioration graduelle des niveaux de sensibilisation sur les questions relatives aux ressources zoogénétiques, de nombreux obstacles doivent encore être surmontés avant de pouvoir assurer l'utilisation durable, la mise en valeur et la conservation des ressources zoogénétiques mondiales. Par conséquent, nous aimerions faire appel aux lecteurs de ce journal – qu'il s'agisse de chercheurs, de personnes travaillant pour les organisations gouvernementales ou non gouvernementales, d'éleveurs ou de membres concernés du public – pour qu'ils favorisent et apportent leur contribution à la mise en œuvre du *Plan d'action mondial.*

[1] *www.fao.org/docrep/010/a1404f/a1404f00.htm*

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Editorial

Las Naciones Unidas han declarado el año 2010 Año Internacional de la Diversidad Biológica. Este año está marcado por numerosos eventos y publicaciones para celebrar la biodiversidad y aumentar la sensibilización acerca papel que ésta desempeña en el mantenimiento de la vida sobre la Tierra y su contribución al medio de vida del ser humano y a la cultura en el mundo entero. La revista Recursos Genéticos Animales tiene el placer de publicar este número especial con el afán de contribuir a las celebraciones del presente año y como medio para promover la gestión sostenible de la biodiversidad en el sector de la ganadería.

En 2010 también se celebra el tercer aniversario de la adopción del *Plan de Acción Mundial sobre los Recursos Zoogenéticos*[1] - el primer marco de trabajo acordado a nivel internacional para la gestión de los recursos zoogenéticos (AnGR por sus siglas en inglés). Es el momento oportuno para valorar si el entusiasmo y el impulso generado con la adopción del *Plan de Acción Mundial* y las actividades relativas a la elaboración de informes que lo precedieron están comenzando a dar sus frutos. Por lo tanto, el primer trabajo de este número, presenta una visión general del avance que ha tenido lugar hasta la fecha, haciendo especial hincapié sobre la puesta en marcha del *Plan de Acción Mundial* a nivel nacional. Los otros 12 trabajos abarcan las cuatro áreas prioritarias estratégicas del *Plan de Acción Mundial.*

Área estratégica prioritaria 1 – "Caracterización, inventario y seguimiento de los riesgos asociados y las tendencias" – está representado por tres trabajos. El primero aborda la identificación y el análisis de las amenazas para la preservación de los AnGR. El segundo describe el papel de las encuestas como medio para obtener datos relativos a los AnGR que pueden servir como base para mejorar la gestión de dichos recursos. El tercero, examina los esfuerzos llevados a cabo para desarrollar los indicadores de la situación y las tendencias de la diversidad genética en los animales domésticos.

Área estratégica prioritaria 2 – "Utilización sostenible y desarrollo" – está representada por dos trabajos. El primero presenta los resultados de un proyecto que investiga las motivaciones y los valores de los granjeros en lo relativo a la cría de ganado en Europa. El segundo trabajo habla del marketing de productos procedentes de razas locales, recurriendo al estudio de casos prácticos en África, Asia y América Latina.

Área estratégica prioritaria 3 – "Conservación" – está representado por cinco artículos, el primero de los cuales proporciona una visión general de la situación de los programas nacionales para la conservación de los AnGR. El segundo artículo examina las potenciales herramientas para la toma de decisiones de tipo económico y analiza los diferentes enfoques de los programas de conservación, y hasta qué punto éstos han sido utilizados en las situaciones del "mundo real". El tercer trabajo examina las opciones y los requisitos legales relativos al desarrollo de los bancos de germoplasma nacionales y regionales para los AnGR, mientras que el cuarto artículo contempla el papel de las áreas protegidas en la conservación de los AnGR. El último trabajo aborda esta área estratégica prioritaria y considera el estado de conservación de los parientes silvestres de los animales domésticos.

Área estratégica prioritaria 4 – "Políticas, instituciones y creación de capacidad" – está representado por dos trabajos. El primero habla del estado de los debates relativos a los derechos de los propietarios del ganado y el segundo describe la aportación que el establecimiento de contactos ha conseguido en el campo de la gestión de los AnGR en Europa.

Mientras que es muy gratificante poder leer acerca de los primeros pasos que los países han llevado a cabo en la puesta en marcha del *Plan de Acción Mundial*, como se describe en el primer trabajo de este número, una visión completa del estado de la puesta en marcha solamente tendrá lugar una vez que la primera vuelta del análisis del avance en la puesta en marcha del *Plan de Acción Mundial* haya sido completado con éxito. Por lo tanto, es esencial que en 2011, como solicitó la Comisión sobre los Recursos Genéticos para la Alimentación y la Agricultura, todos los países elaboren informes sobre de los avances relativos a sus actividades nacionales en la puesta en marcha del *Plan de Acción Mundial*, para que la FAO pueda elaborar un informe de síntesis para su estudio por parte de la Comisión.

Muchos de los trabajos de este número indican que, mientras el avance ha tenido lugar, aún existen muchas lagunas y puntos débiles en nuestro conocimiento acerca de los AnGR y las herramientas existentes para su estudio y gestión de estos recursos. Asimismo, mientras que los programas y las políticas sobre la gestión de los AnGR se están desarrollando y fortaleciendo gradualmente, y se está produciendo una mejora progresiva de los niveles de sensibilización sobre las cuestiones relativas a los AnGR, se necesitan superar aún muchos obstáculos antes de la utilización sostenible, el desarrollo y la conservación de que los AnGR del mundo puedan ser asegurados. Por lo tanto, nos gustaría hacer un llamamiento a los lectores de esta revista – ya sean investigadores, propietarios de ganado o público en general concienciados - para promover y para contribuir a la implementación del *Plan de Acción Mundial.*

[1] *www.fao.org/docrep/010/a1404e/a1404e00.htm*

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Implementing the *Global Plan of Action for Animal Genetic Resources*

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Summary
The first International Technical Conference on Animal Genetic Resources for Food and Agriculture adopted the *Global Plan of Action for Animal Genetic Resources*, the first ever international framework for the promotion of the wise management of animal genetic resources for food and agriculture, endorsed by Food and Agriculture Organization of the United Nations member countries. The adoption of the *Global Plan of Action* has created unprecedented momentum for promoting the sustainable use, development and conservation of the world's livestock diversity. This article describes the first steps that countries have taken in its implementation.

Keywords: *animal genetic resources, Global Plan of Action, intergovernmental process*

Résumé
La première Conférence technique internationale sur les ressources zoogénétiques pour l'alimentation et l'agriculture a adopté le *Plan d'action mondial pour les ressources zoogénétiques*, le tout premier cadre international, approuvé par les pays members de la FAO, visant à promouvoir une gestion rationnelle des ressources zoogénétiques pour l'alimentation et l'agriculture. L'adoption du *Plan d'action mondial* a créé un élan sans précédent en faveur de l'utilisation durable, de la mise en valeur et de la conservation de la diversité des animaux d'élevage dans le monde. Le présent article décrit les premières mesures prises par les pays dans la mise en œuvre du Plan.

Mots-clés: *Ressources zoogénétiques, Plan d'action mondial, processus intergouvernemental*

Resumen
La primera Conferencia Técnica Internacional sobre los Recursos Zoogenéticos para la Alimentación y la Agricultura aprobó el Plan de Acción Mundial para los Recursos Zoogenéticos, el primer marco internacional para promover de la gestión racional de los recursos zoogenéticos para la alimentación y la agricultura, aprobado por los países miembros de la FAO. La adopción del Plan de Acción Mundial ha dado pie a un impulso sin precedentes para promover el uso sostenible, el desarrollo y la conservación de la diversidad del ganado en el mundo. El artículo describe los primeros pasos que los países han dado para su aplicación.

Palabras clave: *Recursos zoogenéticos, Plan de acción mundial, proceso intergubernamental*

Submitted 15 September 2010; accepted 28 September 2010

Introduction and background

Since the 1960s, the Food and Agriculture Organization of the United Nations (FAO) has worked on genetic resources for food and agriculture. Initially, it focused on plant genetic resources, but since 1990 it has been increasingly involved in the area of animal genetic resources for food and agriculture (AnGR). The FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) is a permanent intergovernmental forum, which has developed several international agreements, voluntary undertakings and codes of conduct to promote and facilitate the wise management, access to and benefit-sharing of genetic resources. The CGRFA collaborates with other international organizations, including the Convention on Biological Diversity (CBD) and the World Intellectual Property Organization. FAO leads the CBD's programme on agricultural biodiversity (CBD, 2006, 2008a, 2008b).

Under the guidance of the CGRFA, the first International Technical Conference on Animal Genetic Resources for Food and Agriculture, organized by FAO in collaboration with the Government of Switzerland, took place from 3 to 7 September 2007 in Interlaken, Switzerland. The preparation of the Interlaken Conference comprised a two-pronged approach aimed at achieving both the technical and the policy outcomes requested by the CGRFA. Both elements involved broad stakeholder involvement at national and regional levels. These processes are described in detail by Hoffmann, Boerma and Scherf (2010).

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Technical outcome

The State of the World's Animal Genetic Resources for Food and Agriculture (FAO, 2007a), which was based on 169 country reports, 9 reports from international organizations, scientific literature and FAO's Domestic Animal Diversity Information System (DAD-IS) and statistical database, was launched at the conference. It provides the first comprehensive global assessment of the roles, values, status and trends of AnGR, and of capacity at both country and international levels to manage these resources. It highlights the importance of the livestock sector within agriculture, the importance of AnGR to rural development and food security, and the nature and gravity of the threats to these resources. It also provides an overview of the state of the art in the management of AnGR and identifies areas for capacity building and research. The preparation of the report enhanced worldwide interest in AnGR and recognition of their importance. At the Interlaken Conference, governments stressed that the preparation of this authoritative survey was an important step in achieving the improved management of AnGR, and that it enhanced the basis for further policy development.

Policy outcome

The main achievement of the Interlaken Conference was the adoption of the *Global Plan of Action for Animal Genetic Resources*. It represents a milestone for the livestock sector and a major building block in the development of a coherent international framework for the wise management of agricultural biodiversity. It provides an international framework to support and increase the overall effectiveness of national, regional and global efforts for the sustainable use, development and conservation of AnGR. The *Global Plan of Action* was adopted through the *Interlaken Declaration on Animal Genetic Resources*, in which governments affirmed their commitment to its implementation (FAO, 2007e).

The *Global Plan of Action for Animal Genetic Resources* consists of three parts:

I. Rationale;
II. Strategic Priorities for Action; and
III. Implementation and Financing of the *Global Plan of Action for Animal Genetic Resources*.

The *Global Plan of Action* contains 23 Strategic Priorities for Action, clustered into 4 Priority Areas:

Area 1: Characterization, inventory and monitoring of trends and associated risks (two Strategic Priorities);
Area 2: Sustainable use and development (four Strategic Priorities);
Area 3: Conservation (five Strategic Priorities); and
Area 4: Policies, institutions and capacity building (12 Strategic Priorities).

These Strategic Priorities for Action were developed on the basis of national strategic priorities expressed in the country reports submitted during the preparation of the *State of the World* report, the outcomes of various regional consultations and the conclusions of expert studies and meetings. Current and emerging policy issues and challenges in the field of conservation and sustainable use of AnGR and in the livestock sector more broadly, as identified during this reporting and consultation process, were taken into consideration.

Table 1 presents the Strategic Priorities, grouped according to the level at which they are to be implemented. Most of the implementation of strategic priorities in the areas of characterization, monitoring, sustainable use and conservation will take place at national level, whereas the international community will support countries through the development of standards, guidelines and protocols, and through institutional development and capacity building. International actors, particularly FAO, are also expected to contribute further to the generation of global public goods related to AnGR, through the development of international policies. There are significant linkages between the various strategic priorities and between the various levels of implementation.

Regarding financing and monitoring of the implementation of the *Global Plan of Action*, the 34th FAO Conference requested the CGRFA to oversee the implementation of the *Global Plan of Action* within the context of the commission's multi-year programme of work (MYPoW), in an organized and focused manner (FAO, 2007b, 2009c). Table 2 provides an overview of sectoral and cross-sectoral matters of relevance to AnGR as they will be addressed in the MYPoW. Both the MYPoW and the *Global Plan of Action* are intended to be rolling and evolving in 10-year programmes, which facilitate their integration. The CGRFA was also requested to agree on the modalities for the presentation of progress reports, as well as the criteria and parameters for evaluating progress in the implementation of the *Global Plan of Action*.

At its 12th session, the CGRFA decided on two lines of reporting on the implementation of the *Global Plan of Action* at national, regional and global levels: one on the process of implementation and the other on the impact that implementation has made on the AnGR themselves – a reduction in the loss of AnGR and a better management of these resources are the final measurable indicators of the success of the *Global Plan of Action*. Countries will report on progress in the implementation of the *Global Plan of Action* at 4-year intervals, starting from 2011. FAO will prepare a synthesis report based on the country reports; the second synthesis report will be made available to the CGRFA in 2017, as part of the updated *The State of the World's Animal Genetic Resources on Food and Agriculture* (FAO, 2009c) (Table 2). With respect to monitoring the status of the genetic resources, FAO has been requested to prepare biennial reports on *status and trends of animal genetic resources* (FAO, 2009d) based on the national breed population data reported to the breed database of the DAD-IS. Unfortunately, population data for

Table 1. Levels for the implementation of the strategic priorities.

	SP Area 1. Characterization, inventory and monitoring of trends and associated risks	**SP Area 2. Sustainable use and development**	**SP Area 3. Conservation**	**SP Area 4. Policies, institutions and capacity building**
National	SP 1 Inventory and characterize AnGR, monitor trends and risks associated with them, and establish country-based early-warning and response systems.	SP 3 Establish and strengthen national sustainable use policies.	SP 7 Establish national conservation policies.	SP 12 Establish or strengthen national institutions, including national focal points, for planning and implementing AnGR measures, for livestock sector development.
		SP 4 Establish national species and breed development strategies and programmes.	SP 8 Establish or strengthen *in situ* conservation programmes.	SP 13 Establish or strengthen national educational and research facilities.
		SP 5 Promote agro-ecosystems approaches to the management of AnGR.	SP 9 Establish or strengthen *ex situ* conservation programmes.	SP 14 Strengthen national human capacity for characterization, inventory, and monitoring of trends and associated risks, for sustainable use and development, and for conservation.
		SP 6 Support indigenous and local production systems and associated knowledge systems of importance to the maintenance and sustainable use of AnGR.		SP 18 Raise national awareness of the roles and values of AnGR.
				SP 20 Review and develop national policies and legal frameworks for AnGR.
Regional			SP 10 Develop and implement regional and global long-term conservation strategies.	SP 17 Establish regional focal points and strengthen international networks.
Inter-national	SP 2 Develop international technical standards and protocols for characterization, inventory, and monitoring of trends and associated risks.		SP 11 Develop approaches and technical standards for conservation.	SP 15 Establish or strengthen international information sharing, research and education.
				SP 16 Strengthen international cooperation to build capacities in developing countries and countries with economies in transition,
				SP 19 Raise regional and international awareness of the roles and values of AnGR.
				SP 21 Review and develop international policies and regulatory frameworks relevant to AnGR.
				SP 22 Coordinate the Commission's efforts on AnGR policy with other international forums.
				SP 23 Strengthen efforts to mobilize resources, including financial resources, for the conservation, sustainable use and development of AnGR.

Source: Derived from FAO (2007e).

36 percent of breeds are still missing; this situation has not been improved significantly since 2007. The scarcity of data will also affect the indicator of trends in the genetic diversity of domestic animals that is currently being developed by FAO and which will be included in future status and trends reports. Countries have not agreed on specific targets for livestock genetic diversity or *ex situ* collections.

Table 2. Multi-year programme of work of the CGRFA on matters related to animal genetic resources.

	Animal genetic resources	Cross-sectoral matters
12th Session	Follow-up to the Interlaken Conference	Consideration of policies and arrangements for access and benefit sharing for genetic resources for food and agriculture.
13th Session		Review ways and means of considering the application and integration of biotechnologies in the conservation and utilization of genetic resources. Consider scoping study on climate change and genetic resources for food and agriculture.
14th Session	Review of the implementation of Interlaken outcomes	Review of all relevant international targets and indicators for biodiversity for food and food and agriculture.
15th Session		Consideration of the internalization of the ecosystem approach to biodiversity management in agriculture, forestry and fisheries. Review of the contribution of biodiversity for food and agriculture to the achievement of the Millennium Development Goals.
16th Session	Update of *The State of the World's Animal Genetic Resources*	Presentation of *The State of the World's Biodiversity for Food and Agriculture.*

Source: FAO (2007c – Annex E) and updated 2009 in CGRFA-12/09/Report.

While the main responsibility for implementation rests with national governments, the *Global Plan of Action* calls upon the governments of developed countries to "attach due attention, including funding, to the implementation of activities within the Strategic Priority Areas of the *Global Plan of Action* through bilateral, regional and multilateral cooperation". The implementation of the *Global Plan of Action* will require substantial and additional financial resources and long-term support for national, regional and international AnGR programmes and priority activities. Countries should make every effort to provide support to the implementation of the *Global Plan of Action*. International cooperation should be strengthened and major multilateral and bilateral funding and development institutions should facilitate the implementation of the *Global Plan of Action*, in particular to support and complement the efforts of developing countries and countries with economies in transition. The CGRFA, at its 12th session in 2009, adopted a Funding Strategy for the *Global Plan of Action* (www.fao.org/fileadmin/templates/nr/documents/CGRFA/FundingStrategy_E.pdf), including the establishment of a trust account for the support of national projects.

What happened after the Interlaken Conference?

The *Global Plan of Action* is the only internationally agreed comprehensive framework for the livestock sector that addresses the management of genetic diversity in an ecosystem approach and takes poverty alleviation and food security into account. It was endorsed by FAO membership at the 34th Session of the FAO Conference. It was welcomed by the Ninth Conference of the Parties to the CBD as the internationally agreed framework for the management of AnGR. The *Global Plan of Action* was also welcomed by the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture and the Seventh Session of the UN Permanent Forum on Indigenous Issues.

FAO is involved in several national, regional and global initiatives to implement the *Global Plan of Action*. In partnership with governments, international organizations, research organizations and NGOs, FAO continues to facilitate global and regional collaboration and networks; supports the convening of intergovernmental and technical meetings; maintains and further develops DAD-IS; develops communication products; provides technical guidelines and assistance; coordinates capacity-building and training programmes; and promotes the transfer of technologies related to sustainable use, development and conservation of AnGR. It has developed several guidelines to assist countries in the implementation of the *Global Plan of Action*, two of which have already been endorsed by the CGRFA: *Preparation of national strategies and action plans for animal genetic resources* (FAO, 2009e) and *Breeding strategies for sustainable management of animal genetic resources* (FAO, 2010). FAO's biennial progress reports to the CGRFA give detailed accounts of these activities (e.g. FAO, 2009f).

There are many activities at the national level in which FAO is not involved. In order to obtain a first glimpse of such activities, FAO developed a simple electronic questionnaire, which was widely disseminated in March 2010. Thirty countries – spread across all geographical regions – replied. The results, therefore, provide only a very incomplete snapshot. The official country progress reports to be prepared in 2011 will provide wider coverage and more in-depth reporting. Development of a national strategy and action plan is seen as the first step in the implementation of the *Global Plan of Action*. More than 80 percent of the responding countries indicated that they are either planning, currently developing, have already endorsed or are implementing their national action plans. Countries were also asked to indicate, for each of the four strategic priority areas, activities that are currently being undertaken in research and capacity building, institutional and technical support and awareness raising and information. Table 3 shows that a

Table 3. Country activities undertaken to implement strategic priority areas of the *Global Plan of Action*.

	Strategic priority area			
	1 (characterization, inventory and monitoring of trends and associated risk)	**2 (sustainable use and development)**	**3 (ocnservation)**	**4 (policies, institutions and capacity-building)**
Research and capacity building	73%	77%	73%	63%
Institutional and technical support	53%	60%	70%	70%
Awareness raising and information	63%	57%	60%	67%

Source: FAO questionnaire: responses from 30 countries, multiple replies allowed.

large percentage of the 30 countries that responded to the questionnaire are undertaking such activities and that these are quite equally distributed across the four Strategic Priority Areas.

In addition to the questionnaire described above, annual reports provided by the officially nominated National Coordinators for the management of animal genetic resources of 25 European countries (Annual Country Reports, 2010) were analysed.

The *Global Plan of Action* and the *State of the World* report have been published in all UN languages, and several National Coordinators have prepared national language versions of the *State of the World* "in brief", the *Global Plan of Action* and the *Interlaken Declaration* for awareness raising and policy-making at national level (Austria, Denmark, Germany, Japan, Norway, Poland and Switzerland). A further 17 countries are in the process of preparing local language versions of one or both documents.

Since 2007, several countries have undertaken one-off or regular awareness raising activities, such as expositions and fairs, workshops, web sites and publications for the general public and policy-makers: Albania, Austria, Bhutan, Burundi, China, Croatia, Germany, Hungary, Iceland, Nepal, NORDGEN (an institution under the Nordic Council of Ministers covering Denmark, Finland, Iceland, Norway, and Sweden), Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and United Kingdom. National workshops with the participation of stakeholders have taken place in many countries, including Armenia, Angola, Chile, China, Cuba, Denmark, Ethiopia, Fiji, Hungary, India, Ireland, Malawi, Malaysia, the Netherlands, Nicaragua, Pakistan, the Plurinational State of Bolivia, Poland, Slovakia, Switzerland and Thailand. Countries have continued to develop institutions for national implementation of the *Global Plan of Action*. For example, France has established a national commission for genetics, which brings together stakeholders from the Ministry of Agriculture and Fisheries, research and technical institutes, companies and breeders, organized by species or group of species (see also Table 4). Its national agricultural research institute (INRA) and the French Foundation for Research on Biodiversity work jointly on AnGR, especially on characterization.

Strategic Priority Area 1: Characterization, inventory and monitoring of trends and associated risks

National activities under Strategic Priority Area 1 are diverse, encompassing inventories, censuses and phenotypic and molecular genetic characterization. In most countries, work on inventories has been staggered, either by species (e.g. Belgium surveyed endangered sheep breeds in 2008–2010, cattle in 2010 and pigs in 2011, with a view to selecting donors for a cryobank; the Plurinational State of Bolivia started with camelids and guinea pigs, which will be followed by criollo cattle, sheep, goats and pigs; Chile started with cattle in 2009, followed by sheep and goats) or by activity (Ukraine agreed on breed definitions first and is planning inventory and monitoring). China has completed its second national breed census, the results of which will be published in 2010. In Spain, breeds have been inventoried and described in the official catalogue of Spanish breeds (currently 178 breeds, covering breeding programmes of 159 associations) (Ministerio de Medio Ambiente y Medio Rurale y Marino, 2008).

Kenya included livestock species in its last human population census and plans for a breed survey in 2010. It has already characterized some ruminant breeds. The Plurinational State of Bolivia has undertaken a national mapping of production systems and the related AnGR. Montenegro is working on breed morphological characterization and investigation of some productive traits, the identification of breeds at risk and their geographical distribution and population size. Slovakia is conducting research on molecular characterization of breeds, and its central livestock register and pedigree systems are operational. It is currently developing a national inventory of AnGR, linked to regional and global information systems. Oman and Nepal have phenotypically characterized their local breeds; Oman is now planning for molecular characterization, whereas in Nepal research projects are already underway for the molecular characterization of some breeds. Costa Rica has set up a biotechnology laboratory to advance molecular characterization. Ghana now considers breed characterization an important area for which students are being trained at national universities. The Secretariat of the Pacific Community coordinated the

Table 4. Summary of annual reports provided by 25 European countries reporting on their activities implementing the *Global Plan of Action* from September 2009 to August 2010.

Country	No. of breeds reported to DAD-IS[1]	Strategic Priority 1 (characterization, inventory and monitoring of trends and associated risk)	Strategic Priority 2 (sustainable use and development)	Strategic Priority 3 (conservation)	Strategic Priority 1 (policies, institutions and capacity building)	National strategy or/and action plan planned for 2010/11/under development or adopted	National advisory committee to guide national implementation of GPA established	National law planned to review/ harmonize or adopted in view of GPA	Cryobank for national AnGR planned for 2010/11/ under development or operational
Albania	42	+	+	++	++	√			√
Belgium	71	+	+	++	++			√	√
Croatia	33	++	+	++	++			√	√
Cyprus	18	++	+	++	+				√
Czech Republic	100	+	+	+++	++	√		√	√
Finland	23	++	++	+++	++	√			√
Germany	185	++++	++	++++	+++	√	√	√	√
Greece	37	++	++	+++	++	√	√		√
Hungary	91	++	++	+++	+++		√	√	√
Iceland	6	++	+++	+++	+++	√	√		√
Ireland	34	++	++	++	+++		√		√
Italy	263	++	+	+++	Not reported			√	√
Latvia	10	+	++	++	Not reported				
Montenegro	6	++	+	++	+	√	√	√	
Poland	114	+++	++	++++	+++	√	√		
Romania	114	+	+	+	+	√			
Serbia	41	+++	++	+	+			√	
Slovakia	39	++	Not reported	++	+++			√	√
Slovenia	63	+++	+	+++	+			√	√
Spain	203	++++	++++	++++	++++	√	√	√	√
Sweden	50	+	+	++	+	√			√
Switzerland	38	++++	++	++++	++			√	√
Turkey	92	++	+	++++	++	√	√		
Ukraine	163	+	+	+	+			√	√
United Kingdom	264	+++	++	++++	++	√	√	√	

+ = Actions initiated; +++++ = all actions fully implemented and monitoring regularly ongoing.
[1]Extracted from DAD-IS (www.fao.org/dad-is/) on 8 September 2010.

genetic characterization of pigs and chickens in six countries (Fiji, Niue, Samoa, Solomon Islands, Tonga and Vanuatu). Sixteen European countries (Austria,[1] Cyprus,[2] Estonia,[3] Finland,[4] Georgia,[5] Greece,[6] Hungary,[7] Iceland,[8] Ireland,[9] Italy,[10] the Netherlands,[11] Poland,[12] Slovakia,[13] Slovenia,[14] Switzerland[15] and the United Kingdom[16]) maintain operational national information systems, both in their respective local languages and in English, within the European Farm Animal Biodiversity Information System (EFABIS) network, and automatically exchange data with the European regional information system EFABIS[17] and DAD-IS. In addition, Romania and Republic of Moldova have requested installation of national systems.

Strategic Priority Area 2: Sustainable use and development

The results of the questionnaire also show a wide range of activities in this strategic priority area. While developing countries aim to strengthen the linkages between genetic diversity, livelihoods and food security, several developed countries highlighted the links between genetic diversity and landscapes, and focus their activities on development, labelling and marketing of high-value products.

Togo has set targets for productivity increases in its livestock sector, and evaluated the status of its national ranches and livestock stations in 2009 with the aim of their future rehabilitation. Nepal prepared a draft national animal breeding policy and initiated a dairy cattle cross-breeding scheme, including performance recording and semen collection, with FAO support. It now plans for the collection and processing of semen from goats and pigs to support the sustainable use of these species. In Kenya, the national livestock extension services promote the sustainable use and development of AnGR; the East African Semen and Embryo Transfer Association was formed to promote these biotechnologies. Various cross-breeding programmes are underway for dairy cattle.

Chile and Costa Rica involve the livestock industry in the national livestock genetic improvement plans. Costa Rica has a national programme for beef cattle evaluation, including testing of cross-breeding for dual-purpose breeds. Chile has developed different approaches for commercial and subsistence sectors: the national policy for cattle and sheep genetic improvement aims at improving the competitiveness of beef and lamb production along the whole value chain. The goal is to increase productivity and generate higher value-added animal products by improving management, production and manufacturing practices as well as facilitating access to new and competitive markets. The main strategies are (a) developing an institutional framework to coordinate and address the national plan of action on livestock genetic improvement, including the implementation of breeding and marker-assisted selection mechanisms for different production systems and products, and (b) implementing a national capacity-building strategy to promote the development of human resources and institutional capabilities on animal breeding and genetics. For the subsistence sector, Chile works on the development of participatory programmes to improve local breeds in poor communities to contribute to food security and poverty alleviation strategies, as well as initiatives that promote the trade of local and underutilized products from indigenous communities in the south of Chile.

The Plurinational State of Bolivia links breed characterization with community mobilization, and focuses its breeding efforts on camelids and guinea pigs; both play a crucial role in the livelihoods of poor indigenous communities. Bhutan is implementing a link between breeding and conservation activities.

In Zimbabwe, research institutions are currently busy in maintaining breeding animals at hand. Resources are needed to increase the population of purebred animals for distribution to farmers. Nucleus herds are also being established in Oman.

In Europe (Annual Country Reports, 2010), the work focuses rather on marketing and labelling of high-value products than on genetic improvement. Several countries have programmes that promote local breeds through special products, landscape valuation and agritourism (Montenegro, Slovakia and Spain), special and geographical indication products (Austria, Belgium and Spain). In 2009, Slovakia endorsed legislation to promote direct sale of local livestock products to consumers as long as veterinary requirements are respected. Austria holds annual national information workshops for breeding organizations that are in charge of local endangered breeds. Spain has put in place specific legislation supporting native breeds in extensive production systems that fulfil certain environmental prerequisites, and supporting the development of quality products, in particular from native breeds, to improve their competitiveness. It also monitors the implementation of breeding programmes for native breeds. It plans to support companies that produce local and traditional products and to encourage the use of native breeds for maintaining ecosystems.

[1] http://efabis.raumberg-gumpenstein.at/
[2] http://efabis.ari.gov.cy/
[3] http://efabis.vet.agri.ee/
[4] http://efabis.mtt.fi/
[5] www.efabis-georgia.ge/
[6] www.efabis-greece.gr/
[7] http://efabis.univet.hu
[8] http://efabis.bondi.is/
[9] www.efabis.gov.ie/
[10] http://85.35.185.58/
[11] http://efabis_nl.cgn.wur.nl/
[12] http://efabis.izoo.krakow.pl/
[13] http://efabis-sk.scpv.sk/
[14] http://efabis_si.bfro.uni-lj.si/
[15] www.efabis.ch/
[16] http://efabis-uk.adas.co.uk/
[17] http://efabis.tzv.fal.de/

Strategic Priority Area 3: Conservation

Conservation measures taken by countries encompass *in situ* and *ex situ* measures. The results of an FAO questionnaire on conservation are reported in detail by Boettcher *et al.* (2010).

China publicly announced 138 indigenous breeds as national key-protected breeds. It further certified and made public 119 conservation farms/areas/gene banks at the state level and allocated 30 million yuan (app. 3 million euro) regular budget for AnGR conservation. Ghana makes conscious efforts to recruit and train people for the conservation of indigenous breeds. Six national breeding stations are involved in the conservation of indigenous breeds (cattle, sheep, goats and pigs). Nucleus herds, partially on government farms, have also been established for *in situ* conservation in the Islamic Republic of Iran, Montenegro, Oman, the Russian Federation, Rwanda and Zimbabwe. The Plurinational State of Bolivia focuses on *in situ* conservation of native camelids, guinea pigs and criollo breeds of the other main species because of their crucial role in food security, and therefore stresses community involvement into conservation activities. It charged a newly established research institute with AnGR conservation.

Among 25 European countries (Annual Country Reports, 2010), 72 percent have established cryobank(s) for national AnGR or have planned their establishment for 2010/11. In general, the work of the 25 reporting countries focuses mainly on indigenous breeds, particularly on breeds with small populations. Activities focus on the creation or completion of gene banks, either at national level or distributed across the country, and on subsidy schemes to support rare breeds. In connection to the national information systems established in European countries, national gene bank documentation systems are operational in 11 countries (Austria, Estonia, Finland, Georgia, Greece, Iceland, Italy, the Netherlands, Slovakia, Slovenia and Switzerland).

National cryobanks that already existed in France, the Netherlands and Austria are kept updated. A cryobank will be set up in Belgium progressively from April 2010; breeding organizations are associated with the cryobank project in order to raise their awareness of AnGR conservation. The establishment of a reserve collection of semen and embryos is also underway in Ukraine (cattle, pigs, sheep, horses and fish) and Slovakia. Costa Rica has prepared a feasibility study for a cryobank of semen and embryos and prepared a project proposal for donors. The animal gene bank of Bhutan has started the process of cryoconservation of sheep, poultry and cattle and envisions working with other species such as horses, pigs and yak.

Many European countries use the national allocation from the European Union Rural Development Programme (RDP) (Council Regulation 1698/2005) to support conservation of animal breeds within their jurisdiction. A survey undertaken by the United Kingdom, which covered 21 European countries, showed that only five of them do not have RDP measures for the support of AnGR. Most counties paid on a headage (11 schemes) or livestock unit (5 schemes) basis. They pay breeders of breeds at risk, but the breeders may have to fulfil criteria such as being a member of the relevant breed society or participating in approved breeding programmes. Some countries fund breed societies or rare breed conservation organizations, again linked to approved breeding programmes. The United Kingdom is unique in linking support for AnGR to agri-environment schemes; thus support is only provided for grazing animals (cattle, sheep, equines and goats) (Small and Hosking, 2010).

The Annual Country Reports (2010) from Europe mentioned repeatedly that erosion of indigenous breeds has been slowed down; the ongoing updating of breed data in DAD-IS will help to verify the situation.

Strategic Priority Area 4: Policies, institutions and capacity building

Several countries are currently revising their livestock or breeding policies and strategies (Table 5). Regional organizations, for example in Africa, have included use and conservation of genetic resources in their newly developed strategic plans (AU-IBAR, 2009). Bhutan has developed, involving all relevant stakeholders, a biodiversity policy with a specific chapter on AnGR. Three European country reports (Greece, Ireland and Serbia) (Annual Country Reports, 2010) mentioned the involvement of the national coordinators in updating their respective national biodiversity plans. Nepal has developed an agricultural biodiversity policy and reviewed its national agricultural policies; it has also proposed an animal breeding policy for the sustainable use of AnGR.

Ghana included indigenous breeds in a widely circulated livestock development policy document and in its five-year national agricultural development document, which also serves as a national strategy for donor investment. Chile, Colombia and Peru have started the development of national strategies and action plans with FAO support, and Republic of Moldova requested FAO's assistance in the development of a national information system on animal genetic resources that will start later this year.

Sixty percent of the 25 European countries (Annual Country Reports, 2010) have either adopted their national strategy and action plan or have its development planned for 2010/11; 40 percent have established a national advisory committee to guide the national implementation of the *Global Plan of Action*; 46 percent have adopted a national legal instrument reflecting the needs of AnGR management or planned to review or harmonize such a legal instrument in 2010/11.

The Plurinational State of Bolivia plans to develop a national conservation strategy as the first crucial step in the development of a national action plan for AnGR. In Burkina Faso, the national strategy for the management of AnGR is

Table 5. Countries that are developing and implementing national strategies and action plans for the management of animal genetic resources.

Status	No.	Countries
Not yet planned	5	Burundi, Costa Rica, Ghana, Tunisia, Zimbabwe
Planned	15	Bangladesh, Bolivia (Plurinational State of), Cambodia, China, Iran (Islamic Republic of), Lao People's Democratic Republic, Myanmar, Nepal, Papua New Guinea, Poland, Philippines, Republic of Moldova[1], Rwanda, Sri Lanka, Viet Nam
Under development	21	Belgium, Bhutan, Burkina Faso, Chile[1], Colombia[1], France, India, Kenya, Malawi, Malaysia, Mongolia, the Netherlands, Nigeria, Oman, Peru[1], Russian Federation, Slovakia, Syrian Arab Republic, Togo, Turkey, Ukraine
Endorsed	7	Armenia[1], Denmark, Finland, Iceland, Norway, Romania, Sweden
Being implemented	9	Albania[1], Austria, Canada, Czech Republic, Germany[2], Montenegro, Spain, United Kingdom[2], United States of America

Source: FAO questionnaire and technical reports.
[1]With FAO support as TCPF or TCP.
[2]Developed prior to the endorsement of the *Global Plan of Action.*

currently under development and will cover the period from 2010 to 2025. It is intended that the strategy will be reviewed and updated based on the results achieved.

A number of countries have or are in the process of reviewing and harmonizing their legislative frameworks to reflect the *Global Plan of Action* (Bangladesh, Belgium, China, Croatia, Czech Republic, Germany, Greece, Hungary, India, Italy, Montenegro, the Philippines, Serbia, Slovakia, Slovenia, Spain, Switzerland, Thailand, Ukraine and the United Kingdom). China is currently drafting its 12th national five-year plan (2011–2015), which will include a strategic plan for conservation and sustainable utilization of AnGR. Nigeria is formulating policy guidelines for the use of livestock species nationwide and in particular production systems, focusing particularly on breeding, selection and multiplication of indigenous breeds of cattle, sheep and goats in the ecological zones to which they are adapted. In Slovakia, the agenda on AnGR has been clarified in the latest amendments of the animal breeding act (not yet in force).

Some national funding has been secured in China, the Islamic Republic of Iran and Togo. Several countries mentioned AnGR policies that take into account their many linkages to other sectors: Oman stressed links with trade and zoosanitary issues. Ghana and the Plurinational State of Bolivia emphasized links with poverty reduction policy. Togo has defined a production increase target for its livestock sector, evaluated the functioning of its markets and is developing transhumance codes. Nigeria is reviewing policies that positively affect the use of AnGR, such as establishment of parks, game and grazing reserves and protected grazing in reserves, and places AnGR in a broad livestock-policy context. Some European countries emphasize the links between AnGR and rural development (Austria, Montenegro, Slovakia and Spain).

The Annual Country Reports (2010) from Europe also revealed the differences between the activities undertaken by National Coordinators based in ministries and those based in universities or research institutes. The latter clearly focus on research, whereas the group working in ministries work more strategically for the country.

Under the aegis of the CGRFA and other relevant bodies, governments will further consider measures that affect access to and benefit sharing from genetic resources for food and agriculture. The CBD is committed to finalizing the elaboration and negotiation of an international regime on access to genetic resources and benefit sharing at its Tenth Conference of the Parties in October 2010 in Nagoya, Japan. Access and benefit sharing in the field of the exchange and use of AnGR are a matter of increasing international debate, the outcomes of which will have a large impact on the willingness of various states, agencies, institutions and the private sectors to invest in the conservation and further development of AnGR (FAO, 2009a, 2009b). It will also have major implications for the ability of farmers and livestock keepers, individually and collectively, to continue to play their key roles as custodians of AnGR and innovators in the management of these resources. The need for and potential impacts of frameworks for access and benefit sharing of AnGR need to be carefully assessed. The 36th FAO Conference, in Resolution 18/2009, therefore, invited the CBD to consider adequate treatment of genetic resources for food and agriculture in the international regime, for example, through sectoral approaches that allow for differential treatments of different sectors or subsectors of genetic resources, different kinds of genetic resources for food and agriculture, different activities or different purposes for which activities are carried out. As access and benefit sharing were not covered by our survey, no overview of national activities is available as yet.

Conclusion and outlook

The technical and policy achievements of the Interlaken Conference – the result of over a decade of intergovernmental work – have significantly advanced the AnGR agenda and increased recognition of the crucial role that these resources play in food security and rural development. The *Global Plan of Action* provides an opportunity for all stakeholders to ensure that their efforts converge around an agreed set of common goals and to share experiences. Although only the country progress reports to be prepared

in 2011 and information reported to DAD-IS will give a full picture of activities undertaken and their outputs and impacts, the informal questionnaire results reported in this paper indicate that there is new and unprecedented momentum to enhance the wise management of AnGR as a means to promote food security and sustainable development worldwide. Several national and international actors in relevant areas have started to reflect on how their programmes can contribute to the implementation of the *Global Plan of Action*, and are adjusting their agendas where needed. The activities reported in this paper show that different countries are taking steps at different speeds and with different priorities, suited to their own particular conditions and capacities, based on national funds and other funding sources. Flexibility in national approaches while aiming at a common outcome is an inbuilt strength of the *Global Plan of Action*. Sharing experiences and learning from each other are important components of such a flexible but outcome-oriented process.

Implicitly, the achievements described above reflect passionate efforts to use and conserve AnGR in a sustainable way – by people who depend on them in their daily lives and by people who care about them. At the time of the Interlaken Conference, Kubbinga, Hoffman and Scherf (2007) wrote in this journal about "passing on the fire – to further inspire people to contribute in the management of animal genetic resources". Three years later, we can again highlight the importance of passionate people in the implementation of the *Global Plan of Action*. However, providing adequate support to livestock keepers and breeders, particularly in developing countries, will continue to be central to this endeavour.

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Threats to animal genetic resources for food and agriculture – approaches to recording, description, classification and analysis

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Summary
Numerous threats to animal genetic resources for food and agriculture (AnGR) have been described in the literature. Yet knowledge regarding the threats facing particular breeds and production systems is patchy and often unavailable to relevant stakeholders. Lack of knowledge about threats often goes hand in hand with a more general lack of knowledge about the characteristics, use, management and distribution of livestock breeds. The study of threats should be an integral part of national surveying and monitoring strategies for AnGR. Field surveys are an opportunity to draw upon the knowledge of livestock keepers and other local stakeholders and to map breed distributions. Insights from the field should be integrated, together with information on economic trends, policy developments and the distribution of risks associated with epidemics and other disasters, into a broader understanding of threats. If a large-scale survey of stakeholder opinion is envisaged, it is important to be clear about the objectives of the exercise when designing any classification framework to be used for data collection and analysis. Analysis of threats should aim not only to record the presence or absence of particular threats but also to provide a better understanding of their spatial and temporal dynamics and how they are affected by context (location, production environment, human attitudes and objectives, etc.).

Keywords: *threat, animal genetic resources, survey, classification*

Résumé
De nombreuses menaces aux ressources zoogénétiques pour l'alimentation et l'agriculture ont été décrites dans bon nombre de publications. Pourtant, les connaissances relatives aux menaces auxquelles sont confrontés certaines races et systèmes de production particuliers sont incomplètes et souvent pas disponibles aux parties intéressées. Ce manque de connaissances relatives aux menaces va souvent de pair avec un manque plus généralisé de connaissances en matière de caractéristiques, d'utilisation, de gestion et de distribution des races d'animaux d'élevage. L'étude des menaces devrait faire partie intégrante des stratégies nationales d'enquête et de suivi sur les ressources zoogénétiques. Les enquêtes sur le terrain offrent la possibilité de puiser dans les connaissances des éleveurs et des autres parties prenantes locales et de cartographier la distribution des races. Les idées issues du terrain devraient être intégrées, ainsi que les informations sur les évolutions économiques, sur les développements des politiques et sur la distribution des risques liés aux épidémies et à d'autres catastrophes, à une compréhension plus élargie des menaces. Si l'on prévoit d'entreprendre une enquête à grande échelle sur les opinions des parties prenantes, il est important d'établir clairement les objectifs de cet exercice lors de la conception de tout cadre de classification à utiliser pour la collecte et l'analyse des données. L'analyse des menaces devrait viser non seulement l'enregistrement de la présence ou de l'absence de menaces particulières, mais également une meilleure compréhension de leurs dynamiques spatiales et temporelles et des façons dont elles sont affectées par le contexte (emplacement, environnement de production, et comportements et objectifs des êtres humains, etc.).

Mots-clés: *menace, ressources zoogénétiques, enquête, classification*

Resumen
En la literatura aparecen descritas numerosas amenazas de los recursos zoogenéticos para la alimentación y la agricultura (AnGR, por sus siglas en inglés). Todavía el grado de conocimiento acerca de las amenazas que afrontan determinadas razas y sistemas de producción es incompleto y frecuentemente no está al alcance de los diferentes agentes implicados. La falta de conocimiento sobres las amenazas a menudo va de la mano con la falta de conocimiento más general sobre las características, utilización, gestión y distribución de las razas de ganado. El estudio de las amenazas debe ser una parte integral de las encuestas y de las estrategias de seguimiento nacionales para los AnGR. Las encuestas de campo representan una oportunidad para recurrir al conocimiento de los propietarios del ganado y otros agentes locales implicados, y diseñar el mapa de la distribución de la raza. Las percepciones del campo deben ser integradas, además de con la información sobre las tendencias económicas, desarrollo de políticas y la distribución de los riesgos asociados con las epidemias y otros desastres, en una comprensión más profunda de las amenazas. Si se prevé una encuesta a gran escala para conocer la opinión de los agentes implicados, es importante tener claro los objetivos del ejercicio a la hora de

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diseñar clasificaciones en el marco de trabajo para ser usadas en la recopilación y análisis de datos. El análisis de las amenazas debe perseguir no sólo registrar la presencia o ausencia de amenazas particulares, sino también proporcionar una mejor comprensión de sus movimientos, desde el punto de vista espacial y temporal, y como se ve afectados por el contexto (localización, producción medioambiental, y actitud humana y objetivos, etc.).

Palabras clave: *amenaza, recursos zoogenéticos, encuesta, clasificación*

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Introduction

Numerous threats to animal genetic resources for food and agriculture (AnGR) have been described in the literature. Relatively recent examples of publications focused on the analysis of threats include Rege (1999), Rege and Gibson (2003), Tisdell, (2003), LPPS and Köhler-Rollefson (2005), Gibson *et al.* (2006) and FAO (2007a, 2009a), but concerns over the loss of AnGR diversity and attempts to analyse the causes of such losses have been building for several decades (see Kubbinga, Hoffmann and Scherf, 2007).

In some cases, it has been possible to show that particular breeds[1] have been adversely affected by clearly identifiable events or processes (e.g. a disease outbreak, a new regulation or the spread of indiscriminate cross-breeding). In other cases, plausible arguments have been put forward based on the link between genetic diversity and the diversity of production systems and the roles and values of livestock within them: if the production systems that sustain diverse livestock populations disappear or are transformed, or if the uses to which animals are put (and the products obtained from them) become more homogenous, AnGR diversity is likely to be threatened. Such insights have given rise to some significant steps forward in efforts to safeguard AnGR diversity. For example, European Union legislation recognizes the potential threat to rare breeds posed by disease-control measures and allows for some, strictly controlled, exemptions (FAO, 2007a). However, in many respects the analysis of threats has remained at a basic level. Few attempts have been made to quantify, in any way, the impacts of the various threats, to analyse their temporal and spatial dynamics, or to account for their potential to act cumulatively or drive each other. At the same time, responses to threats have tended to be reactive in nature: i.e. the trigger for action (if there is any action) is not the existence of a threat but its observed consequences, usually a decline in the population size of one or more breeds. Moreover, lists of priority actions for improving the sustainability of AnGR management tend to offer little in terms of prioritization or targeting of the various options. Key questions that arise from these observations include whether, and how, strengthening the analysis of threats might contribute to more proactive, better-prioritized and better-targeted management, and what can be done to promote and facilitate such analysis?

[1] In this paper, loss of AnGR diversity is described largely in terms of the decline of breed populations towards extinction. However, it should be recognized that breed diversity does not fully reflect genetic diversity.

What is a "threat"?

The term "threat" is widely used in the context of AnGR management. Many publications describe the status of AnGR (number of breeds at risk of extinction, etc.), then note that the situation is worrying, and then proceed to explain the situation in terms of "threats". Other terms, such as "pressures" (LPPS and Köhler-Rollefson, 2005) or "causes of loss" (Tisdell, 2003) are sometimes used in much the same context. By implication, threats are the factors that have caused breed populations to fall and (of even greater concern) "threaten" to drive them further towards extinction. The study of threats, thus, embraces both the history of breeds (some of which may already be extinct) and – to borrow a definition from the Oxford English Dictionary – "indications of impending evil" to breeds (OED, 2010). In the latter sense, a threat may not yet have had any actual impact on the threatened populations. Threats increase the probability that breeds will, in the future, decline towards extinction. However, this definition does not fully capture the sense in which the term is used in this paper. A "threat" is not merely a factor that increases risk. Rather, it is a generator, or potential generator, of change (negative change from the perspective of AnGR diversity).

Primary data sources

One constraint to the analysis of threats is a lack of raw data. *The State of the World's Animal Genetic Resources for Food and Agriculture* (SoW-AnGR) (FAO, 2007a) laments the lack of data upon which to base global analysis threats, and the *Global Plan of Action for Animal Genetic Resources* (GPA) (FAO, 2007b) calls for improved "characterization, inventory and monitoring" of "risks" to AnGR as a basis for improved understanding of these risks and improved decision-making in support of conservation and sustainable use (Strategic Priority Area 1).

These broad goals beg several questions: What kinds of data are needed? What data are feasible to obtain? How can they be collected? How can they be made available to those who need them?

The straightforward answer to the third question above is that surveying and monitoring strategies for AnGR should include collection of data on the nature of threats and how they change over time. This might include building breed-wise elements into ongoing monitoring of risks to livestock populations and production systems (e.g. disease or drought) as well as specific AnGR-focused surveys. At the time of writing this paper, guidelines on surveying and monitoring are being prepared by FAO as part of a series of publications intended to support countries in their implementation of the GPA (Woolliams, Pilling and Scherf, 2010). This paper does not pursue the practicalities of surveying. However, a few points should be noted. Domesticated breeds or animal populations are continually under human observation, and conscious human decisions are among the most important influences on the dynamics of these populations (how their sizes and structures change). If a breed has declined, livestock keepers, at least, will have some knowledge of why this has occurred. Surveys are a means to tap into this knowledge and integrate it with information from other sources into a broader understanding, which can be drawn upon by all stakeholders whose decisions may affect the future of the respective populations or who wish to draw lessons to be applied elsewhere. Depending on whether, and how well, such processes have been conducted, the "knowledge" circulating among the wider AnGR stakeholder community may be a more or less accurate representation of the true forces affecting AnGR diversity. This *caveat* should be borne in mind whenever stakeholders, particularly those not closely involved in the management of the breeds and production systems under consideration, are canvassed for information on threats to AnGR.

As noted above, livestock keepers' knowledge is not the only source of information that can be drawn upon as part of efforts to survey and monitor threats to particular breeds or production systems. If the geographical distribution of a breed has been established, and this distribution has been georeferenced electronically (FAO/WAAP, 2008), it may become possible to overlay this with maps that show the distribution of factors that may threaten AnGR. A straightforward application of this approach would be to identify breed populations that lie within zones that are prone to natural disasters or disease outbreaks. It might also be applied to mappable proxies for economic drivers of change, such as access to markets; to the distribution of environmental problems, such as the degradation of rangelands; or to the distribution of land-use practices with the potential to disrupt livestock keeping. Mapping exercises could be extended to include predicted future trends: for example, the consequences of climate change. Other relevant sources of information include records and forecasts of consumer demand for livestock products, and trade and labour-market parameters. Policy-related threats can be investigated on the basis of relevant policy documents, accompanied, if possible, by studies of their implementation on the ground.

Global assessments

The outputs of a well-planned surveying and monitoring strategy are likely to be very valuable to stakeholders involved in planning the future management of the breeds and production systems from which the data have been collected. It is less clear how they should be integrated into wider analysis of the threats to AnGR – for example, at regional or global levels – or how such analyses should be taken forward if the basic breed- and production system-level data collection and analyses have not been implemented.

Global stakeholder surveys

The only attempts to undertake a comprehensive quantitative global analysis of threats to AnGR have been the surveys reported in the Background Study Paper prepared for the Twelfth Regular Session of the Commission on Genetic Resources for Food and Agriculture, held in October 2009 (FAO, 2009a). Respondents were asked to list up to five threats affecting the various production systems found in their regions and to list up to three threats affecting specific breeds (up to three breeds of the respondents' choice from each of the following groups of species: poultry, large ruminants, small ruminants, pigs, equines and camelids). The main conclusion that can be drawn from these surveys is that stakeholders (at least those with access to FAO's e-mail discussion network DAD-Net) are in broad agreement with the literature cited above that AnGR are threatened by changes to production systems driven by economic and market factors and the availability of resources; that inappropriate policies contribute to the loss of diversity; that breed populations can sometimes be threatened by epidemics, by other disasters or by the measures implemented to deal with them; and that lack of awareness and lack of capacity contribute to threats or hamper responses. These are not negligible findings in terms of the light they shed on the consensus that exists among stakeholders regarding the nature of the challenges involved in promoting more sustainable management of AnGR. However, it is not clear whether the outcomes of these surveys have provided decision-makers with guidance that is more detailed or relevant than that which was already available in the SoW-AnGR and the GPA.

Potential use of the Domestic Animal Diversity Information System

Some consideration has been given to the idea of adding a new set of data-entry fields to the Domestic Animal

Diversity Information System (DAD-IS) in order to allow National Coordinators for the Management of Animal Genetic Resources to record details of the threats faced by their countries' breeds. This is an appealing proposal in terms of its potential for raising awareness of the threats facing particular breeds. However, it would not be straightforward to implement; nor would it necessarily provide data that would be particularly useful for improving the management of the threats identified.

The simplest objective for a large-scale exercise in gathering threats-related data from National Coordinators would be to record which national breed populations are affected by which threats. This could be done by providing a list of threats with options to tick "yes" or "no", or by allowing open-ended "free-text" responses. The former type of question has generally been used in DAD-IS in order to facilitate language-independent data collection and analysis. The frequency with which particular threats are reported among particular groups of breeds (see examples in FAO, 2009a) might be interpreted as indicating the priority that should be given to the respective threats in the management of the respective populations. However, as the raw data would not show how severely breeds are affected by the various threats, the outcomes would be no more than indicative of the relative significance of the threats across the population as a whole. It might be possible to implement a system of ranking or scoring threats and perhaps weighting breeds according to their risk status. However, this would add substantially to the complexity of the data-entry process. A further complicating factor would be the need to ensure consistency in terms of the time periods being considered (descriptions of the past or predictions of the future).

Even asking data providers to signal the presence or absence of a set list of threats would require a carefully designed data-entry screen. Moreover, the list of threats would have to be sufficiently detailed to allow descriptions that are not merely generalizations relevant to almost all breeds, but not so long as to be intimidating to data providers. The categories would have to be interpretable unambiguously and consistently by the data providers and by potential users of the data. One option would be to devise a framework of categories and subcategories that would provide structure to the data-collection process and might be reflected in the subsequent analysis and discussion of the threats (see examples in FAO, 2009a).

Classifying and describing threats

The potential implementation of a "threats" module in DAD-IS and lessons learned from the above-described stakeholder surveys have raised the issue of classifying threats as a concrete problem. This paper owes its origin to these operational questions. The issue may, however, be of wider significance. Analysis, communication and planning always require phenomena to be grouped and labelled in some way.

Clearly, if threats are to be grouped into categories, this needs to be done on the basis of some shared properties. The objectives of facilitating analysis, communication and planning imply two distinct sets of properties that might be considered. On the one hand, it may be possible to identify properties that indicate the need for particular types of action to combat a threat, on the other it may be possible to identify properties that characterize the relationship of the threat to other threats and/or to the dynamics of the affected animal populations. In other words, the latter properties describe the position of the threat within a hypothesized framework of causality. To provide a more concrete example: the threat that there will be an outbreak of a transboundary disease that kills large numbers of animals could be characterized, according to the former perspective, by the need for action by animal health services; according to the second perspective, the epidemic threat might be characterized as being driven, *inter alia*, by increased international trade and, in turn, driving threats posed by culling measures or poorly planned restocking programmes; to take a step further, it might be concluded that the epidemics belong to a class of threats that have both direct and indirect impacts on AnGR.

The criteria and levels of detail that are appropriate for describing and classifying threats will depend on the objectives of the respective survey or analysis. For example, to learn that a breed "lacks competitiveness" may be useful from a management perspective in that it highlights the possible need for improved marketing of the breed's products or implementation of a breeding programme. However, it is not so useful if the objective is to understand how the breed has come to be threatened (and learn lessons from this). The breed's lack of competitiveness may have arisen because of a range of factors: competition may come from other breeds, crosses, species or production systems, or may come from imported products; consumer demands may have changed, as may the requirements of marketing and retailing chains. The availability and cost of the inputs required by different breeds and species may also be significant factors affecting competitiveness. A wider interpretation could include competition from non-livestock products and services or non-livestock livelihood activities. In this example, a change of perspective has required the single "threat" to be divided into ten or more subcategories, which in turn could operate in an enormous number of combinations.

A further point to emphasize with respect to classification frameworks is that they should not be treated as definitive. No list of threats will be able to account for all the specific situations that arise in "real-life" production systems. For example, the SoW-AnGR (FAO, 2007a) noted the potential for "apparently minor and innocuous" changes to have negative impacts on breeds, citing the example of the Icelandic Leadersheep, which declined because greater use of conserved forages reduced the significance of winter grazing in which the Leadersheep played an important role (Dýrmundsson, 2002).

Potential use of frameworks from the environmental field

Environmental problems, and threats to wild biodiversity, are often discussed in terms of the Driving Forces–Pressures–State–Impact–Response (DPSIR) framework (EEA, 2006) or its less-elaborate predecessor the Pressure–State–Response (PSR) framework (OECD, 1993). How relevant are these frameworks to AnGR and particularly to the question of classifying threats? Briefly to introduce the DPSIR framework: Driving forces "are the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns" (EEA, 2007). Pressures "include the release of substances (emissions), physical and biological agents, the use of resources and the use of land. The pressures exerted by society are transported and transformed into a variety of natural processes which manifest themselves in changes in environmental conditions" (ibid.). The pressures affect the "state" of the environment (conditions of soil, water, biodiversity, etc.), which creates adverse "impacts" of various kinds (e.g. on human and ecosystem health or resource availability). The "impacts" generate "responses" on the part of society which can be directed towards any of the other four components of the framework.

The concept of driving forces or "drivers of change" has been used in the AnGR field to describe broad social, economic and environmental forces that lead to changes in the livestock sector that in turn may threaten AnGR diversity. The main forces discussed in these terms are changes in demand – driven in turn by factors such as economic growth, rising human population, increased purchasing power and urbanization; trade and globalization; technological developments; and environmental problems such as degradation of natural resources and the effects of climate change (FAO, 2007a; Seré *et al.*, 2008). However, these forces, for the most part, do not directly affect the demographics of livestock populations. Their effects are mediated by actions taken within the livestock sector: at the levels of policy-making, development intervention, or the individual livestock holding, breeding enterprise or livestock-keeping community. The DPSIR's "pressures" concept does not adapt easily to this context. Like much analysis of environmental problems, this element of the DPSIR framework assumes a "natural" world that is "pressured" as a consequence of human actions, either via incidental side-effects, such as the emission of polluting substances, or via the overuse of resources. In contrast, the genetic resources of domesticated species are dependent on human activity for their existence and are threatened more by under- than by overuse.

A more general criticism levelled at the DPSIR approach is that its "apparently deterministic 'causal' description inevitably down plays the uncertainty and multiple dimensions of causality inherent in complex environmental and socio-economic systems" (Maxim, Spangentberg and O'Connor, 2009). Given the intricate set of relationships that exist between livestock populations, the production environment, the economics of livestock production and the breeding and husbandry decisions taken by humans, together with the potentially devastating, but "uncertain", impacts of aberrant events such as epidemics, this criticism may be even more pertinent in the AnGR field. Indeed, the criticism could apply to any of the hierarchical threats framework that attempts to reflect patterns of cause and effect.

Another related framework – "Driving Forces–State–Response" – was developed specifically to take into account "the specific characteristics of agriculture and its relation to the environment" (OECD, 1999). Within this framework, there is no assumption of a hierarchy among the "driving forces". They are simply divided into three groups or domains: "environmental", "economic and social" and "farm inputs and outputs" (which include "management practices"). It is recognized that "agricultural activities can both produce *beneficial impacts* to enhance environmental quality" (ibid.) (emphasis in original). From here it is only a short step to a framework that recognizes the essential role of humans (particularly livestock keepers and breeders) in maintaining livestock diversity. Clearly, any analysis of threats needs to take these three domains into account. However, it is not clear whether focusing on each as a separate unit of analysis is any more useful than focusing on the production system as a whole. For example, to understand the threat from "rangeland degradation", even at the herd level, requires that it be analysed in terms of the interactions between livestock husbandry and the "environment". Its overall significance can only be understood taking "economic and social" factors into account – to which can be added policy factors – at both household and wider levels.

In conclusion, the DPSIR and similar frameworks cannot simply be adopted wholesale as frameworks for analysing threats to AnGR. The "driving forces" concept highlights the fact that many threats to AnGR are driven by developments outside the livestock sector itself. It is important to recognize the significance of these forces. However, it is also important to recognize that protecting AnGR diversity – promoting sustainable use and conservation – will largely depend on actions taken within the livestock sector (or at the interface between the livestock sector and fields such as land-use planning, rural development and wildlife conservation). This requires understanding of how the societal driving forces are transformed into more specific threats at the level of the production system and how the various stakeholders within the livestock sector can affect outcomes for AnGR.

A final (rather more positive) point to note about such frameworks, particularly the simpler PSR version, is that they underscore the need to monitor threats (pressures, driving forces, etc.), and responses (conservation and

other management programmes) in addition to monitoring the state of AnGR (measures of diversity and risk status) (see, for example, MIRBSE, 2007). This is significant, for example, in the field of indicator development for AnGR (Martynuik, Pilling and Scherf, 2010); separate indicators for each of the three components of the PSR framework may be required.

Relating threats to opportunities for action

Different threats to AnGR present different challenges and different opportunities for action. They pose different technical and logistical problems. They involve different political challenges, and they require action from different groups of stakeholders. The discussion of threats in the SoW-AnGR (FAO, 2007a), although it did not specifically set out to establish a classification framework, reflected this orientation on opportunities for action. Three broad groups of threats were distinguished "livestock-sector trends: economic, social and policy factors"; "disasters and emergencies" and "epidemics and disease control measures" (ibid.). The latter two groups were dubbed "acute" threats. Among the "non-acute" threats, it was noted that some arise because of "policies and methods in the specific field of AnGR management" (more concretely, this means the management of breeding and the choice of breeds) rather than because of more general trends affecting livestock production systems. The two "acute" groups of threats plus the "breeding" threats loosely equate to three distinct, if overlapping, fields of intervention within which AnGR management activities can be implemented and three sets of stakeholder groups towards whom awareness-raising activities can be directed – options are briefly described in the following three paragraphs. Threats associated with more general livestock sector trends are described in the remaining paragraphs of this subsection. Table 1 illustrates the possibility of translating identified threats into opportunities for action. Note that these opportunities include both "hands-on" AnGR management actions (breeding programmes, marketing, conservation programmes, etc.) and awareness-raising activities targeted at particular groups.

Acute threats may require the geographical distribution of breed populations to be addressed in order to reduce their vulnerability to devastating losses (*ex situ* conservation measures or other interventions to promote more widely dispersed use). Additionally, awareness of AnGR issues may need to be raised among the stakeholders responsible for implementing policies and programmes related to the management of disasters, emergencies and epidemics. Particular attention may need to be given to culling programmes and to post-disaster restocking programmes (FAO, 2006).

Threats associated with the management of animal breeding are, in contrast to many other threats, very much within the purview of "primary" AnGR stakeholders: planners of national breeding policies and strategies, government services and NGOs involved in livestock development, commercial suppliers of genetic material and livestock keepers themselves. These stakeholders, at least, should be interested in avoiding "inappropriate" activities that threaten AnGR diversity. In reality, however, it may not be clear what qualifies as "inappropriate". In some circumstances, decisions that lead to decline in the population of particular breeds may be considered necessary in order to promote objectives such as increasing production levels and improving livelihoods. Most individual livestock keepers and breeders cannot simply adopt breeding strategies that promote diversity if these strategies do not provide competitive economic returns. National breeding policies that take into account the need to maintain genetic diversity are therefore essential.

Key pitfalls to be avoided in the management of animal breeding include the introduction of breeds that are poorly adapted to the production environments in which they are to be kept, indiscriminate or poorly planned cross-breeding, overuse of a restricted group of sires for breeding and overslaughter of high-quality breeding animals. Positive steps that can be taken include promoting awareness of good breeding practices and, where appropriate, the implementation of structured breeding programmes.

Beyond the immediate sphere of breeding management, a great range of interacting forces drive changes in livestock production systems and may threaten AnGR. Breeds are often threatened by forces that undermine two important prerequisites for their survival as functioning elements of production systems. First, it is necessary that some humans within or associated with the production system value the breeds sufficiently to maintain them. This normally requires that the breeds meet some livelihood, social or cultural function(s) and can compete with other potential means (if such exist) of meeting this/these functions. Second, the keepers of the breeds require access to the resources needed to maintain them. Many of the forces that undermine these prerequisites cannot be addressed directly through AnGR management activities. An additional dilemma involved in dealing with such forces is that sometimes the threat to AnGR is the "flipside" of broadly positive developments, such as increased availability of alternative products, services and livelihood opportunities.

AnGR-related concerns have little or no influence on policies in the spheres of general economic development, trade or technology. Within the agricultural and livestock sectors, decision-makers should be made aware of the consequences for AnGR diversity of policies that promote, for example, the spread of large-scale, high external input production. However, it cannot be assumed that eliminating such developments will, or should, be a policy objective. In such cases, the appropriate response may be to seek to adapt AnGR management to changing circumstances: for example, by seeking new ways of marketing the

Table 1. Threats to animal genetic resources and potential actions to address them.

Threats		**Examples of actions to address the threats***		
Disasters and emergencies	Livestock mortality	Avoid concentrating breed populations in limited geographical areas. Implement cryoconservation and other *ex situ* measures as an insurance.		Promote awareness of AnGR issues among government services, and NGOs involved in managing disasters and emergencies – particularly restocking programmes.
	Effects of restocking	Ensure restocked animals are suited to local production system. If exotic breeds are brought in consider the need for conservation programmes for local breeds.		
Disease epidemics and control measures	Livestock mortality	Promote improvements to animal health services.	Avoid concentrating breed populations in limited geographical areas. Implement cryoconservation and other *ex situ* measures as insurance.	Promote awareness of AnGR issues among stakeholders involved in managing epidemics or in drafting relevant policies and legislation – particularly related to culling measures.
	Culling	If local laws allow for exemptions to culling for conservation objectives, ensure that herds/flocks of rare breeds are registered/certified in advance with the relevant authorities.		
	Effects of restocking	Ensure restocked animals are suited to the local production system (the availability feed resources will often be a crucial factor) . If exotic breeds are brought in, consider the need for conservation programmes. Promote awareness of AnGR issues among government services and NGOs involved in restocking programmes.		
Inappropriate breeding management, strategies and policies	Lack of national breeding policies and strategies	See right-hand column.		Develop or review national breeding policies and strategies.** Ensure they take into account the need to maintain genetic diversity. Provide the resources needed for their implementation.
	Excessive concentration of the breeding sector in the hands of few private companies			
	Introduction of breeds poorly adapted to local conditions	Raise awareness of the need to match breeds to production. Raise awareness of the potential contributions of local breeds to livestock development. Raise awareness of implications of introducing breeds (e.g in terms of feed requirements)		
	Irresponsible promotion of alternative breeds by national authorities, commercial operators or NGOs			
	Lack of structured breeding programmes	Implement structured breeding programmes (where feasible and relevant to livestock development strategies).		
	Indiscriminate cross-breeding	Promote awareness of good breeding practices.		
	Failure to avoid inbreeding			
	Excessive slaughter of good breeding animals			
	Inappropriate use of reproductive technologies			

Continued

Table 1. Continued

Threats						**Examples of actions to address the threats***
Changing production systems and livelihoods	Economic growth, trade, technological development	Changing consumer /market demands				Explore opportunities to improve marketing of the products of threatened breeds and/or to implement genetic improvement programmes involving the threatened breeds. Build the capacity of breeders to adapt to changes. Improve characterization of breeds and production environments. Promote awareness of the potential contributions of local breeds to livelihood and development objectives. As and where feasible, promote review (and if appropriate amendment) of policies, such as input subsidies, that put local livestock breeds at a competitive disadvantage. Ensure decision-makers are aware of impacts on AnGR.
		Availability of alternative livelihood activities				
		Replacement of livestock functions				
		Increased specialization in single products				
		Competition from/diffusion of other breeds				
		Competition from other species				
		Diffusion of cross-breeding				
		Competition from/diffusion of alternative production systems				
	Decline of or changes to livestock-related cultural / leisure activities					Support initiatives that promote cultural uses of threatened breeds. Promote awareness of potential loss of cultural heritage.
	Lack of resources for livestock keeping	Pasture	Degradation of pastures	Promote effective management of pastureland and water – including where relevant ensuring that mobile livestock management remains a viable option.	Promote awareness of impacts on livestock-based livelihoods and AnGR – and potential positive contributions of livestock – among relevant decision-makers (land use, wildlife range management etc.).	Promote involvement of livestock keepers and other relevant stakeholders in planning natural resource management, land use, service provision and conflict resolution Promote awareness of, and respect for traditional knowledge and management institutions.
			Loss of pastures to other uses			
			Restrictions on access to pastures			
		Water	Shortages			
			Restrictions on access			
		Lack of/inadequate livestock services		Promote improved provision of services, particularly those that are appropriate, affordable and accessible to pastoralists and small-scale farmers.		
		Inadequate marketing system/infrastructure				
	Economic instability			Promote awareness of potential contributions of livestock keeping and AnGR to sustainable livelihoods, food security, nutrition and management of natural resources (as elements in broader strategies to combat these problems).		
	Effects of HIV/AIDS					
	Conflict and insecurity					
	Effects of repeated droughts					
	Effects of endemic diseases			Where appropriate, support the integration of genetic resistance or tolerance into disease control strategies.		
	Loss of traditional knowledge			See right-hand column.		
	Loss of traditional livestock management institutions					
	Impact of rules and regulations (e.g. animal health, food safety, animal welfare, nature conservation) – including costs of compliance			Promote reviews of regulatory frameworks and their implications for AnGR particularly for traditional and extensive production systems, and their amendment as and where necessary and feasible.		
	Inadequate livestock sector policies			As and where feasible, promote review (and if appropriate amendment of) livestock sector policies. Ensure decision-makers are aware of impacts on AnGR.		

Continued

Table 1. Continued

Threats			Examples of actions to address the threats*
Cross-cutting threats	Lack of awareness of AnGR		Promote awareness of significance of AnGR and the impact of threats among decision-makers and the general public.
	Lack of consultation with livestock keepers and breeders in AnGR-related decision making		Implement decision-making that is more participatory.
	Policy and legal frameworks that are inadequate or lack AnGR focus (national and international)	Trade	As and where feasible, promote review (and if appropriate amendment of) the relevant frameworks. Ensure decision-makers are aware of impacts on AnGR.
		Zoosanitary	
		Intellectual property	
		Access and benefit-sharing	
	Climate change	More frequent climatic disasters	See relevant rows above.
		Changing production environments	
		Rising sea levels	Establish conservation programmes in non-threatened (higher) locations.
		Effects of climate change mitigation and adaptation on animal production	Promote integration of AnGR management issues into the planning of adaptation and mitigation measures.

The merged cells in the right-hand columns indicate that certain activities can address multiple threats.
* Strategies to combat threats should preferably be integrated within a national strategy and action plan for AnGR – see FAO (2009b).
** See FAO (2010a).

products and services provided by the threatened breed or establishing a breeding programme (FAO, 2010a, 2010b).

Among the resource-related threats, problems in ensuring that animals have sufficient feed and water are among the most prominent. There will often be potential to respond to these threats through improved management of rangeland or by ensuring equitable access to pastures and water resources (which might include addressing constraints affecting migration routes taken to reach the grazing resources in question). Other resource-related threats (e.g. shortages or high costs of non-pasture feed or other inputs) might be addressed through well-targeted development efforts, as might poor or absent livestock services (animal health, marketing, etc.).

The SoW-AnGR (FAO, 2007a) noted the existence of additional threats that it described as "higher-level" in the sense that they are significant drivers of change across several of the four above-described categories, while the reciprocal effects are less marked. (Given the multiple levels on which many threats operate, the term "cross-cutting" may be more appropriate than "higher-level".) Climate change, for example, has the potential to drive gradual changes in production systems (e.g. affecting the availability of feed resources), to cause more frequent climatic disasters, and to increase the exposure of breed populations to unfamiliar epidemic diseases. Other cross-cutting threats include lack of awareness of the significance of AnGR among decision-makers and lack of consultation with livestock keepers and other relevant stakeholders (FAO, 2009a), both of which contribute to many threats that arise because of policy and management decisions.

Relating threats to their contexts

A breed's prospects for survival may depend not only on threats *per se*, but also on otherwise neutral aspects of the production system that make the breed more vulnerable. An example that has received increasing attention in recent years, particularly following the 2001 foot-and-mouth disease epidemic in the United Kingdom, is endemism (concentration of a breed population in a limited geographical area). Carson *et al.* (2009) show that substantial numbers of British sheep breeds are highly concentrated in their distributions (in 10 out of 12 breeds studied, 95 percent of the population was located within a radius of 65 km of the mean geographical centre of the breed's distribution).

The size and physical geography of the typical holding on which a breed is kept may also be significant. To take another example from the United Kingdom: During the years following the Second World War, British heavy horse breeds all faced the threat that their function was being replaced as a consequence of the mechanization of agriculture. However, the Suffolk Horse experienced a more precipitous decline than comparable breeds such as

the Shire (reaching a critically low population size from which it has struggled to recover ever since). According to Open2.Net (2005) the reason that the Suffolk was particularly affected was because the large, flat, arable farms of its native East Anglia were easier to mechanize than farms in other parts of the country where other breeds predominated. In such circumstances, an effective and well-targeted strategy to promote conservation and sustainable use of AnGR requires not only recognition that a given class of breeds is affected by a given threat but also knowledge of how the threat plays out in different production environments and of how different breeds are distributed across these production environments.

The attitudes and objectives of individual livestock keepers may also be significant to how they respond to economic and social drivers of change. Gandini *et al.* (2010), for example, identify seven subtypes among European cattle farmers keeping local breeds. The farmers are grouped first according to their main goals or orientation in livestock keeping and then subdivided according to their attitudes, degree of expertise, attitudes to quality, aesthetic values, degree of commitment to livestock production and degree of interest in processing and marketing. Some breeds are reported to be particularly linked to one group of farmers (ibid.). This suggests the possibility that the different breeds may be differently affected by the driving forces or threats that prevail generally in European cattle production and that differentiated development strategies may be needed to promote their sustainable utilization.

Describing the magnitude and dynamics of threats

The surveys reported by FAO (2009a) aimed at identifying not only whether or not particular threats affected particular production systems, regions, species or breeds but also to explore the dynamics of the threats identified. Clearly, devising some means of recording the dynamics of threats is an important objective. If presence alone is recorded, a major threat that is increasing in severity will remain indistinguishable from a minor threat that is declining in its severity. One of the lessons of the above-described Suffolk Horse story may be that breeds are particularly threatened when their production systems change rapidly. This would emphasize the significance of understanding the temporal dynamics of threats.

The respondents to the FAO (2009a) surveys were asked to describe threats in terms of their spatial scale, the speed with which their effects become evident, frequency of occurrence, expected future trend in their severity and their impact in terms of the proportion of the population that is expected to be lost. These questions were not easy to answer. Particularly problematic was the attempt to describe the proportional magnitudes of the effects of individual threats, which in reality do not usually act alone but interact, drive each other and act cumulatively.

Ideally it would be possible to calculate the probability that, in the presence or absence of particular threats, at a given time in the future the size of a given breed population will be within a given range. Other things being equal (costs, conservation priority of the breeds, etc.), priority would be given to threats with a high probability of rapidly diminishing the breed populations in question. An all-encompassing priority-setting model of this type is probably not feasible given the many interacting forces involved in driving population dynamics. Fortunately, such a model is not a *sine qua non* of better-focused and timelier interventions to address threats to AnGR. A more realistic scenario is that decision-makers will draw together information on the potential magnitude and dynamics of threats from a range of sources, which may include models of the impact of individual threats, previous experiences in the respective production system and elsewhere, and mapping exercises that relate breed distribution to the distribution of threats or other aspects of the production system. Among individual threats, it might be possible to build breedwise elements into epidemiological or agro-ecological models that predict the dynamics of livestock populations. Heffernan (2009) offers a model for the effects of cross-breeding following post-disaster restocking with non-native breeds. Another option, rather than trying to quantify the impacts of particular threats, is to quantify trends in the threats themselves, i.e. to treat the problem as one of devising indicators of "pressures" on AnGR diversity within a PSR framework.

Identifying production environments that are unfavourable to AnGR diversity

An alternative approach to explaining the decline of AnGR diversity is, rather than directly investigating the mechanisms involved, to use statistical methods to compare the characteristics (e.g. socio-economic and land-use factors) of locations where AnGR diversity has declined to the characteristics of locations where it has thrived (Hoffman, 2010; Joost and Matasci, 2010). In this way, it may be possible to identify conditions that are particularly unfavourable for AnGR diversity. It is possible that this approach might contribute to early warning systems for AnGR. Areas that appear to be sliding towards an AnGR-unfavourable state might be identified and targeted for further investigation and, if necessary, interventions to promote sustainable use and conservation of the local AnGR. Good availability of both AnGR diversity data (population size and structure) and the other relevant data sets would be necessary in order to establish such a system.

Discussion

The most pressing need in the analysis of threats to AnGR is to build on the broad insights set out in publications such as the SoW-AnGR and the GPA in order to establish

country- and production system-level strategies with which to address threats and promote the sustainable use, development and conservation of AnGR. This requires information on the nature and dynamics of the threats affecting the production systems concerned. Threats should, therefore, be one of the focuses of surveying and monitoring strategies for AnGR. It is essential that livestock keepers and other stakeholders with in-depth local knowledge be consulted as part of these surveys. Advantage should also be taken of the opportunities offered by georeferencing breed distributions and relating these to other georeferenced data sets, whether related to physical threats to the animals or to economic, social and environmental developments. Studies of events such as epidemics may provide indications of the magnitude and dynamics of the impacts that are to be expected when threats strike (Roper, 2005; FAO, 2007a).

If a large-scale survey of stakeholder opinion is envisaged, it is important to be clear about the objectives of the exercise when designing the survey tools and analytical framework. In doing this, it is important to identify the target audience for the outputs of the proposed analyses and to consider whether, and how, the intended outputs may provide guidance that can promote more sustainable management of AnGR.

Collecting and analysing data on threats, and communicating the outcomes, may require threats to be grouped or classified. Frameworks should be applied with sufficient circumspection and flexibility to allow unexpected insights to be assimilated. If they are to provide useful new information, they must allow respondents to address a wide range of topics, while also encouraging them to provide answers that are more than platitudes. However, the tools used for data collection should not overburden the respondents.

In listing threats and grouping them into categories, it is important not to lose sight of the diversity of livestock production environments. No classification framework will be able to account for all the complex dynamics of livestock production systems and their effects on livestock populations. It should not be assumed that the same "threat" will have the same consequences everywhere. Breed histories may be useful in drawing attention to unusual threats or combinations of threats, or highlight the significance of interactions between threats and other aspects of the production system. It is unfortunate that relatively few case studies of breeds that have become extinct or that have suffered sharp falls in their populations have been written up and made easily available to interested stakeholders.

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Surveying animal genetic resources to manage biodiversity

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Summary
There is a wide international consensus that there is an urgent need to compile national inventories of animal genetic resources, supported by periodic monitoring of trends and threats, to underpin their effective management. This paper gives an overview of how to set about this task, primarily through national strategies but also through ad hoc surveys. It is important to establish stakeholder involvement at an early stage of setting up the national strategy so that the surveys can be made more effective and the emergent actions can be more readily implemented. There are a wide variety of tools available for surveying and monitoring, ranging from mapping expeditions to household surveys and censuses, encompassing methods associated with rapid rural appraisals. Tools have different strengths and weaknesses and their relative cost effectiveness will depend on objectives. Performing a baseline survey is a key step because it serves as a reference point for future monitoring; however, to be cost effective, more rudimentary surveys may be needed beforehand to establish reliable design parameters. Calibration of one method to another is an important task when several methods are being used for monitoring. Planning and design, communication, sensitive field work, data management and an analysis appropriate to the objectives are all necessary elements of a successful survey.

Keywords: *livestock breeds, monitoring, inventories, rural appraisal, tools, threat management, risk management*

Résumé
Au plan international, il est largement convenu que, pour soutenir une gestion efficace des ressources zoogénétiques, il est très urgent de dresser des inventaires nationaux accompagnés du suivi périodique des tendances et des menaces. Ce document présente les façons d'entreprendre cette tâche, essentiellement par le biais des stratégies nationales, mais également par le biais d'enquêtes spéciales. Il est important de définir l'engagement des parties prenantes à un stade précoce de l'organisation de la stratégie nationale pour que les enquêtes puissent se faire de façon plus efficace et que les actions qui en résultent soient mises en œuvre plus rapidement. Plusieurs outils différents sont disponibles pour les enquêtes et le suivi, des expéditions cartographiques aux enquêtes et au recensement des ménages, englobant les méthodes associées aux évaluations rurales rapides. Les outils ont des forces et des faiblesses différentes et leur rentabilité relative dépendra des objectifs. La réalisation d'une enquête initiale est une étape fondamentale car elle sert de point de référence pour le suivi; toutefois, pour assurer sa rentabilité, des enquêtes plus rudimentaires pourraient être nécessaires à l'avance pour établir des paramètres conceptuels fiables. L'étalonnage d'une méthode par rapport à une autre est une tâche importante lorsque plusieurs méthodes sont utilisées pour le suivi. La planification et la conception, la communication, les travaux délicats de terrain, la gestion des données et une analyse appropriée des objectifs sont tous des éléments nécessaires d'une enquête couronnée de succès.

Mots-clés: *Races d'animaux d'élevage, suivi, inventaires, évaluation rurale, outils, gestion des menaces, gestion des risques*

Resumen
Hay un amplio conceso a nivel internacional acerca de que existe la urgente necesidad de reunir inventarios nacionales de recursos zoogenéticos, apoyados por la supervisión periódica de las tendencias y las amenazas, para respaldar la gestión eficaz de los mismos. Este documento ofrece una visión general acerca de cómo emprender esta tarea, fundamentalmente a través de estrategias nacionales, pero también por medio de encuestas diseñadas específicamente para este fin. Es importante determinar la participación de las diferentes partes interesadas en una fase inicial de la creación de la estrategia nacional, para que las encuestas puedan ser realizadas de la forma más eficaz posible y las acciones de urgencia sean implementadas más fácilmente. Existe una gran variedad de herramientas disponibles para la supervisión y el seguimiento, que van desde asignación de expediciones a las encuestas de familias y censos, que abarca métodos asociados con la rápida evaluación de las zonas rurales. Las herramientas tienen fortalezas y debilidades y su relativa relación coste-rendimiento dependerá de los objetivos. La realización de una encuesta de partida es un paso clave, dado que sirve de punto de referencia

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Palabras clave: *Razas de ganado, supervisión, inventarios, valoración rural, herramientas, gestión de las amenazas, gestión del riesgo*

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Introduction

The *Global Plan of Action for Animal Genetic Resources*, adopted in Interlaken in 2007, and subsequently endorsed by all Food and Agriculture Organization of the United Nations (FAO) member countries and the European Union, states: "Understanding the diversity, distribution, basic characteristics, comparative performance and the current status of each country's animal genetic resources is essential for their efficient and sustainable use, development and conservation … without such information, some breed populations and unique characteristics they contain may decline significantly, or be lost, before their value is recognized and measures taken to conserve them" (FAO, 2007). In the words of a well-used saying in business "You can't manage what you don't measure". The truth of this saying applies as much to animal genetic resources (AnGR) as it does to industrial processes, and is reflected in the words of the *Global Plan of Action*, which recommend: "complete national inventories, supported by periodic monitoring of trends and associated risks, is a basic requirement for the effective management of animal genetic resources".

It is a serious concern that knowledge of the world's AnGR is extremely patchy and often unavailable to those who need it. This observation flags three challenges. First, there is an urgent need to conduct baseline surveys that document AnGR and the full range of their capacities. Second, it is necessary to establish, through effective monitoring schemes, how each of these resources is faring in a rapidly changing world. Third, knowledge obtained through surveys needs to be made widely available, particularly to decision-makers and livestock keepers. These challenges can best be met through the development and implementation of coherent national strategies for surveying and monitoring AnGR, although ad hoc surveying initiatives may also make worthwhile contributions to the knowledge base. A forthcoming guideline publication – one of a series being prepared by FAO in support of country-level implementation of the *Global Plan of Action* (FAO, 2009, 2010) – will address surveying and monitoring of AnGR. This paper, which draws on the draft version of the guidelines, focuses on describing the range of surveying tools that are available, their strengths and weaknesses and how they can be combined effectively.

Motivations for surveying and monitoring

There are a range of reasons for surveying and monitoring. Perhaps the most obvious are concerned with enhancing knowledge of a breed or a set of breeds: for example, their population size and structure and trends in these, geographical distribution, characteristics, performance and production environments. The importance of understanding the production environment should be emphasized as comparisons of performance among breeds are only useful if they take into account the conditions in which the animals produce. Documenting breeds that have not previously been recorded in national inventories may be another important objective. Other motivations for surveying and monitoring activities may include documenting the cultural aspects of livestock production and breed utilization, documenting indigenous knowledge, providing the information needed for strategic planning of livestock development in order to improve livelihoods, establishing priorities for conservation programmes and meeting international reporting obligations arising from the Convention of Biological Diversity.

A further and increasingly important reason for surveying is to identify and monitor threats to AnGR, particularly given the uncertainties associated with climate change and its potential effects on breeds' production environments. Threats include the prevalence and impact of diseases, both endemic diseases and emerging exotic diseases, and degradation of the environment, as well as a range of socio-economic factors. Proactive management, informed by monitoring of threats, will reduce the loss of AnGR diversity, whether or not the threats are prompted by climate change.

Surveying and monitoring strategies: an overview

A surveying and monitoring strategy will typically involve a baseline survey followed by a series of monitoring surveys. The baseline survey will generally aim to provide a thorough assessment of the targeted AnGR and cover many aspects of the production systems in which they are kept. The monitoring surveys may be more narrowly focused on population size and structure and other aspects of the production system that have potential to change rapidly, for example, a known threat. Thus, a monitoring strategy is a coordinated series of surveys that aims to identify trends over time, with the baseline survey serving as a reference point for subsequent surveys. However, as described in the text below, a full baseline survey in many cases will not be the first surveying activity undertaken, because cost-effective baseline surveys depend upon good design. Therefore, smaller, preliminary surveys

to obtain the information needed for planning the baseline survey will often be required.

The development of a national surveying and monitoring strategy is an opportunity to identify national priorities for data collection and to explore the options for addressing these priorities in a cost-effective way. There are potential synergies with other data-gathering activities in the livestock sector and beyond, and these should be explored. Most usefully, a working group, comprising a wide range of stakeholders, should be brought together to develop the strategy. Key candidates for inclusion in the strategy working group include representatives of farmers' or livestock keepers' associations including, where relevant, indigenous and local people's organizations, breed societies, extension services, breeding companies, non-governmental organizations or research institutions with experience in gathering livestock-related data, public or private sector organizations involved in planning conservation programmes, and the national office of statistics and other public bodies that gather or utilize data from the relevant locations and production systems.

Planning and implementing a survey: an overview

Managing an AnGR survey involves a series of activities: planning, awareness raising, field operations, data management, data analysis, data archiving and reporting of results (Figure 1). These will be described in detail in FAO's forthcoming surveying and monitoring guidelines. Points to be emphasized include the importance of considering data management and data analysis at an early stage in the planning process (well before the field operations begin). No element of the survey should be planned in isolation from the others. The plans for the field will need to be drawn up with the objectives for data analysis in mind, which in turn should be based on a realistic assessment of the resources available for the field work. It is also essential that sufficient attention and resources be devoted to data management. Failure to do so may undermine the whole survey effort. Also not to be overlooked are procedures for archiving data for the future. Legal and ethical issues related to the ownership of, and access to, the data need to be considered at an early stage in the planning; for example, in many countries there is legislation concerned with protecting personal information and legislation concerned with freedom of information, and hence, clarity in how these conflicting concerns apply to the different elements of the data from a proposed survey is essential.

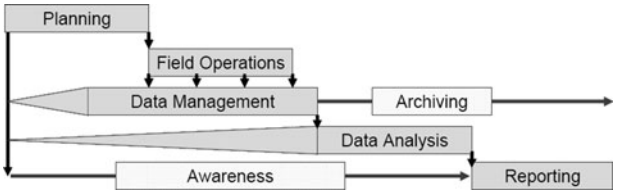


Figure 1. Phases in the planning and implementation of a survey.

Another element that requires careful attention is the survey's communication strategy. Two phases of communication need to be planned for. The first of these phases is communication with stakeholders during the period before the field operations. This may, for example, involve bringing community leaders or other local stakeholders into the planning process, and the use of a range of communication channels (community meetings, leaflets, posters, radio, television etc.). The communication strategy must take into account the need to obtain the "prior informed consent" of those providing the data. The second phase is communicating the results of the survey promptly to all relevant stakeholders so that they can integrate the results into their work. The significance of the results to different stakeholder groups should be assessed. Appropriate channels for communicating with each of these groups should be identified. A wide range of media should be considered: face-to-face events, printed materials, audio, film, web-based communications etc. Reporting should not stop at this point. Surveys are being conducted for a purpose: to provide data that can be used to improve the sustainable management of AnGR in the areas surveyed. A workshop should be organized at which stakeholders can discuss the outcomes of the survey and plan any actions that need to be taken in response.

If the survey has been undertaken as an independent initiative (e.g. a university research project) rather than as part of a national strategy, it is important that the organizers of the survey communicate the outputs of the survey to the country's national coordinator for the Management of Animal Genetic Resources, so that *inter alia* the relevant data can be used to update national entries in the Domestic Animal Diversity Information System. Indeed, it is always important that national coordinators be informed in advance about plans for such surveys.

Tools for surveying

Surveys in which well-designed subsamples of holdings are visited (the so-called household surveys) are not the only type of surveys relevant to AnGR. Rather, there are a range of tools that can be used for surveying. Developing a surveying strategy requires decisions to be taken as to which tools to use and how they can best be combined to achieve the objectives that have been set, taking into account all the concrete circumstances in which the surveys will take place: technical capacity, the social structure of the rural communities being surveyed, the challenge posed by the rural landscape and – last but not least – funding. What follows is an examination of the strengths and weaknesses of some of the surveying tools that are available and of how they can be combined into an effective strategy.

Mapping expeditions

The term "mapping expedition" can be used to describe a set of journeys carried out, with little contact with local

communities, for the purpose of obtaining rudimentary information on AnGR, such as the approximate geographical distribution of particular breeds and species. A mapping expedition may provide the information needed to design well-focused follow-up surveys that will use other methods. The strengths of mapping expeditions include speed and low cost. The main weakness is that only very limited knowledge of production systems and livestock-keeping communities is obtained.

Transects

In some locations, it may be possible to estimate the size of the animal population using transect methods, similar to those developed for surveying wildlife, in which trajectories are drawn *a priori* across the area targeted by the survey and then traversed. Counts are made of the animals observed along the transect, and complex statistical methods are then used to estimate numbers in the area as a whole. The observations made along the transect might be extended to include quantitative measurement of threats or indicators of threats (e.g. degradation of the grazing land).

Following a transect may involve little contact with the local community, but it may provide an opportunity to identify communities that can be targeted by follow-up surveying activities. Transect methods can only work quantitatively if the trajectories travelled along are representative of a wider area whose dimensions have been measured. Thus, meaningful outputs may only be obtainable in a small minority of production systems. These include systems in which a uniform production environment extends over a wide area (e.g. plains or bush-land) or systems that are "one-dimensional" (e.g. those that are only practised on river banks – in which case the trajectory can follow the river). It is more usual for livestock to be found in clusters associated with human settlements or particular geographical features (e.g. watering holes), and in such cases, to ensure representative sampling, it is more appropriate to sample the clusters in a manner analogous to the household sampling described below, rather than a transect.

The strengths of transect methods include speed, low cost and provide a means to estimate the population size. The weaknesses are that results provide little information on production systems, the associated communities and the causes behind the outcomes observed; limited applicability in the majority of production systems; and a lack of documented experience in their use to survey livestock (examples from the wildlife field include Peres, 1999; Andriolo *et al.*, 2005; Ogutu *et al.*, 2006).

Aerial surveys

Aerial surveys can be thought of as airborne mapping expeditions and transects. As such, they suffer from a lack of contact with local livestock keepers. Aerial surveys can be relatively expensive because of the need for costly material resources (equipment, including air transport and cameras) and highly skilled personnel. They are appropriate only for sparsely populated and open landscapes such as those found in sub-Saharan Africa, Central Asia and parts of South America. Furthermore, the livestock need to be clearly visible from the air, which excludes small animals, such as rabbits and poultry, and housed animals (e.g. pigs in some systems). Despite these limitations, poor accessibility, unpredictable movements of pastoralists' herds and security uncertainties may justify the use of low-level aerial surveys as a means to estimate the population size and structure of livestock populations and their spatial and seasonal distributions. In some areas, such surveys may be the only realistic option for achieving systematic coverage and obtaining the data needed for comprehensive statistical analysis. Aerial surveys alone are likely to be insufficient to identify livestock populations by breed and will need to be combined with other tools for quantifying this aspect. However, aerial surveys may be an important component of surveying strategies in which other methods are used to overcome their deficiencies. Descriptions of the use of aerial methods to survey livestock can be found in Marriott and Wint (1985) and Bourn *et al.* (1994). Further examples (involving wild and feral animals) are provided by Bayliss and Yeomans (1989) and Andriolo *et al.* (2005).

The strengths of aerial surveys include providing means to cover wide areas rapidly and to quantify livestock numbers. Weaknesses include the need for relatively expensive equipment and personnel; limited usefulness without the use of complementary methods; lack of opportunity to gain information on production systems, the associated livestock-keeping communities and the causes behind outcomes observed; and poor results if the landscapes are not open.

Household surveys

A household survey involves collecting data from a random sample of households (or holdings) chosen from among all households (or holdings) meeting a specific set of criteria. The larger is the sample as a fraction of the whole, the more accurate the survey will be as an estimator of the target group. Information is obtained via interviews, normally held face to face with household members. Such interviews are commonly based on a questionnaire, which may be more or less structured depending on the objectives and circumstances of the particular survey. With good design, household surveys allow good control over bias and precision, making them an optimal choice for baseline surveys. Examples of AnGR-focused household surveys include those described by Ayalew, van Dorland and Rowlands (2004), Rowlands *et al.* (2003) and Zulu, Simoongwe and Zulu (2003).

A good design for a household survey and associated questionnaires requires some basic prior knowledge of the

production system being surveyed. For example, if the survey is intended to provide estimates of absolute numbers of animals, then it is necessary to have a good estimate of the total number of households from which the sample of households to be surveyed is drawn. A household survey may, therefore, have to be preceded by the use of other, more exploratory, tools. In some production systems, livestock-keeping households may be mobile or may split during parts of the year. Such factors have to be taken into account in the design of household surveys.

The strengths of household surveys include their flexibility for addressing a wide range of objectives; the relative ease with which data collected can be quantified, standardized and pooled compared to those obtained in other ways; good opportunities to minimize bias; the relative ease with which precision can be calibrated to match the remit; and providing opportunities to collect both quantitative and qualitative data, including some probing for more personal issues. The weaknesses include the large amount of time needed and the high cost.

Censuses

In a technical sense, a census is a household survey of wide scope and in which all qualifying households are interviewed. Most countries implement national agricultural censuses once every 10 years; they may also implement more specific livestock censuses (see for example Government of Pakistan, 2006). In some countries, the national censuses are based on sampling rather than on complete enumeration of the target populations. To date, very few national censuses have collected data at the level of the breed rather than the species. However, the inclusion of breed-wise data collection in censuses is an option that countries may wish to consider in the future.

Rapid appraisals

The term "rapid appraisal" is used here to describe data-collection activities that involve interaction with livestock keepers and/or other knowledgeable stakeholders, but are not based on formal sample-based surveys. Rapid appraisals are important alternatives to household surveys. They are normally field based, i.e. require visits to the communities targeted, and are multidisciplinary in nature (FAO, 1993). Field activities may be framed or complemented by the use of information drawn from secondary sources such as previous studies and reports, government statistics and records, maps of the area, research papers and historical texts (FAO, 2000). Triangulation – the use of several sources in order to validate the data obtained – is a key characteristic of the approach.

Rapid appraisals involve the use of techniques that are intended to allow local people to "teach" outsiders about their livelihoods, their problems and their knowledge (FAO, 1993). Such techniques were among the main antecedents and building blocks of the "participatory" approaches to development that gained popularity during the 1990s. Adopting a more participatory approach can help to ensure that the data collected are interpreted correctly by the surveyors so that the social, cultural and agricultural significance of the data is understood. Furthermore, it increases the chances that the outcomes and the follow-up actions will benefit those that have supplied the data, and that support for the surveying process is built up, thus facilitating future surveys.

There are several reasons why rapid appraisal tools are likely to be important to a surveying and monitoring strategy and often to individual surveys. One of these is that household surveys are major undertakings in terms of organization and resources and may not always be possible. It is unlikely to be possible to repeat such surveys with sufficient frequency to monitor rapidly changing aspects of AnGR and their management. Moreover, a survey that focuses exclusively at the household level and obtains information only from individual livestock keepers may not be sufficient as a means to collect data on some important aspects of the production system – either because they require specialist knowledge (marketing opportunities, forthcoming policy changes or development initiatives, precise diagnosis of animal health problems etc.) or because dealing with them in individual interviews would be too time consuming or too constrained by the need for structured data that are easy to analyse. Another consideration may be that if households are treated in isolation from each other, there is little or no opportunity for communities to develop a sense of collective ownership of the surveying process or to assert their views regarding the outcomes of the survey and the actions arising from them.

While in some circumstances rapid appraisals may stand on their own, it will often be appropriate to use them in association with formal household surveys. As mentioned above, in order to be effective, a household survey may need to be preceded by activities that are more open ended and exploratory. Alternatively, rapid appraisal techniques may be used in parallel with a household survey in order to provide alternative perspectives and additional details. Another likely scenario is for a household survey to be followed, after some time has elapsed, by the use of rapid appraisal tools to investigate whether any significant changes have occurred – in other words for monitoring. Parallel use of a household survey with a rapid appraisal gives an opportunity to calibrate the rapid appraisal as a monitoring tool. If a country already has a sound baseline of data and information on most of its AnGR, monitoring using rapid appraisal techniques may be the main constituent of its surveying and monitoring strategy.

Rapid rural appraisals may include group meetings and the use of key informants. In the context of AnGR surveying and monitoring, breed societies (where they exist) are likely to be an important source of information. While breed societies with herd or flock books provide a relatively straightforward means of monitoring what is

happening to specific breeds, this approach is not without its problems. For example, breed societies are non-governmental organizations, and for smaller breeds the decision-making and office work are often done on a voluntary basis. This may make communication difficult, and in some cases the society will not automatically provide information each time a request is made but will consider each request separately. Furthermore, breed societies are a special interest group, and while information on numbers is documented in the herd and flock books, these numbers may not represent the total population of a breed but instead reflect only those owned by livestock keepers who are sufficiently motivated to register. Societies may also be open to bias in minimizing threats to the breed and maximizing interest in the breed. In summary, breed societies are a valuable but imperfect asset for surveying and monitoring. A rapid rural appraisal should always seek to use triangulation to avoid biases, whereby several independent sources are used to provide a cross-validation on the emerging outcomes.

In summary, the strengths of rapid appraisals include speed relative to household surveys; low cost relative to household surveys; opportunities for greater involvement of the local communities who manage the AnGR; opportunities to investigate the causes behind the outcomes identified; and, in discussions unrestricted by predetermined questionnaires, the possibility of discovering new and surprising information. The weaknesses include greater difficulty in obtaining objective quantitative information than in household surveys; greater difficulty of standardizing and pooling data; and, in some cases, less opportunity for the surveyors to observe AnGR directly. Further information on the use of rapid and participatory appraisal techniques in livestock research can be found in the following publications: Kirsopp-Reed and Hinchcliffe (1994), FAO (2000), Conroy (2001), LDG (2003), Conroy (2005), Dorward *et al.* (2005), FAO (2005) and LPPS and Köhler-Rollefson (2005) and on the FAO Participation web site (www.fao.org/participation/).

Matching tools to objectives

Not all tools will be suitable for answering all the questions addressed by a surveying and monitoring strategy or an individual survey. Table 1 gives an indication of the suitability of the various tools for answering different kinds of questions concerning AnGR.

Mixing tools: a perspective

During the early stages of a surveying and monitoring strategy, fundamental gaps in knowledge will need to be addressed. It is possible that at this point an aerial survey or a mapping expedition will provide a means to acquire a lot of valuable information. Rapid appraisals may also be useful during the early stages of the strategy as a means to obtain information on, *inter alia*, the roles of livestock and threats to AnGR; these appraisals may frame more detailed follow-up surveys. In discussing this point, Marsland *et al.* (2001) quote the following concise summary from ABRMC (1989), which is highly relevant despite the very different setting of marketing: "Prior to any large-scale quantitative study particularly in a relatively unknown market, it is strongly recommended that a qualitative phase of research is initially conducted, the main purpose being to understand the vocabulary and

Table 1. An indication of the usefulness of tools to address objectives listed when used as a single strategy

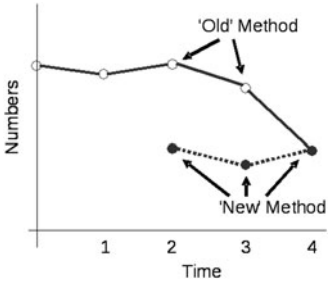
	Mapping expedition	Transect[1]	Aerial survey	Rapid appraisal	Household survey	Census
Identification						
Is Breed A present in the survey area and listed in the relevant breed inventory?	*****	*****	*	***	*****	****
What are the characteristic identifiers of Breed A?	***	***	*	****	*****	*
Characterization						
How many animals of Breed A are there?	*	****	*	**	*****	****
What is the geographical distribution of Breed A?	*****	***	*	***	*****	*****
What role does the breed play within the production environment in which it is kept?	*	*	*	****	*****	**
Is Breed A associated with a particular socio-economic or cultural group?	*	*	*	***	*****	***
Does Breed A have any important adaptations or unique traits?	*	*	*	*****	*****	*
What are the threats to breed A?	*	**	*	*****	*****	*
Monitoring						
Is Breed A increasing or decreasing in numbers?	*	****	*	****	***	****
Is a recognized threat to Breed A increasing or decreasing?	*	**	*	*****	***	**

Asterisk numbers indicate relative usefulness.
[1]Assuming a transect approach is feasible in the production environment.

language used by customers as well as understanding their motivations and attitudes towards given services, products and usage associations. The findings of the qualitative research provide invaluable input to the quantitative stage in terms of the line and tone of questioning, and of course the overall structure and content of the quantitative phase". This emphasizes the benefits of using participatory approaches at an early stage when knowledge and understanding are vague.

Box 1. Maintaining continuity in surveying and monitoring outputs.

The specific methods used to survey a particular area or production system may change over time as circumstances in the areas and production systems target change and as new techniques are developed. The shift from one method to another needs to be carefully managed in order to ensure comparability between older and newer data. It is important that at the time of the change, both the old and the new methods are used at the same time for at least two, preferably more, appraisals. This allows the old method to be "calibrated" against the new method, so that continuity of information can be maintained. The figure demonstrates the importance of calibration. A survey team has used an "old" method to count the number of animals during several rounds of surveying (the results are indicated by the empty circles in the figure). A decision is taken to introduce a new, more suitable, method of collecting data (results are indicated by the shaded circles). If the new method is introduced at time 4 (see the figure) with no preparation, the conclusion may be that a sharp drop in numbers has occurred (the solid line in the figure represents the official figures that would be reported by the survey team). Of course, it may be pointed out that the method has changed, but at best this will only lead to the conclusion that nothing is clear, leaving an uneasy fear that a drop has indeed occurred. Conversely, if the survey team had prepared for the change and used both methods at times 2 and 3, then it would be clear that the new method provides lower values than the old method and that the rate of change indicated by the two methods is very similar. In this case, it can be concluded that there has been no change in the population trend – perhaps even a slight increase in numbers. The change to a more suitable method has been implemented successfully. If the new method had only been used alongside the old method on one previous occasion, it would not have been possible to see both: (a) the new method tends to result in lower estimates of population size than the old method, and (b) the relative sensitivity of the new method to changes in population size compared to the old method.



Even though rapid appraisals may indicate trends and even numbers (e.g. by scaling answers from representatives at group meetings by the numbers they might represent), there are inadequacies and biases in these kinds of methods. Consequently, the results they produce may be very misleading for the purposes of planning. It is, therefore, highly recommendable that at some point a baseline household survey be undertaken. This will provide the opportunity for more comprehensive information gathering and to minimize biases. Findings that are reliably quantified with reasonable precision have greater impact – people sit up and take notice! The preliminary work using rapid appraisals should help with the design of the household survey. Moreover, if the rapid appraisals have been of a participatory nature, the planning may be smoother and communication easier.

Results from a baseline household survey will form a reference point for monitoring. It is, however, unlikely to be feasible to repeat household surveys at sufficiently short intervals to allow fully effective monitoring of changes in breed population size and structure. Rapid appraisals (including, where possible, obtaining information from breed societies) are therefore likely to be important components of the monitoring strategy. It is sensible to conduct rapid appraisals at the same time (or very close to the same time) as the household survey to enable an assessment of the reliability of the rapid appraisals. This has long-term benefits: first, it will offer an opportunity to change the protocols for the rapid appraisals to eliminate the worst errors; and second, because a relationship can be established between the rapid appraisal and a more formal survey, the monitoring programme will be able to use the cheaper rapid appraisal methods with greater confidence (see Box 1). Once in a while, however – say once every decade – a household survey is required to keep the calibration reliable.

Conclusions

Surveys are essential building blocks of effective national action to improve the management of AnGR and to meet international reporting obligations. Well-planned national surveying and monitoring strategies will help ensure that surveying efforts are coordinated and cost effective. A range of surveying tools is available to be drawn upon as part of surveying strategies or individual surveys. Tools should be selected to match data-gathering objectives, which in turn should aim to address gaps in knowledge and to track changes over time with sufficient accuracy to allow remedial measures to be taken when threats to AnGR diversity are identified. If the surveying tools used change over time, it is important that strategies account for the need to calibrate methods to ensure comparable results that can be used to provide an accurate indication of trends.

Even if no national surveying and monitoring strategy is yet in place, it is important that surveying initiatives do not take place in isolation. Relevant stakeholders, and in particular national coordinators for the management of AnGR, should be made aware of any proposed surveys, supplied with the outputs of the survey, and involved in the planning and implementation of any follow-up activities.

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Indicators: Do we have effective tools to measure trends in genetic diversity of domesticated animals?

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Summary
The need to provide policy-makers with succinct, yet informative, messages is widespread in biodiversity management, and has led to the development of various "indicators" that can serve this purpose. While global data on the status of animal genetic resources for food and agriculture (AnGR) have been made available in a number of publications, the issue of developing a global indicator for AnGR has come to prominence only relatively recently. This paper describes the policy background to these developments and reviews initiatives in AnGR indicator development at national and regional levels. It also outlines some of the issues raised at an expert meeting on indicators organized by Food and Agriculture Organization of the United Nations (FAO) in January 2010. To date, AnGR indicator development has largely been restricted to Europe. Globally, options are restricted by the limited availability of data. The expert meeting favoured an indicator set that describes both the relative abundance of native versus non-native breeds and summarizes breed risk status. The former will require a new breed classification system that is acceptable to countries and applicable globally. The risk-status categories of approximately 64 percent of reported breeds are available in the Domestic Animal Diversity Information System, but a lack of regular updates of countries' breed population data means that trends cannot be described adequately at present.

Keywords: *indicator, genetic diversity, domesticated animals*

Résumé
Dans le domaine de la gestion de la biodiversité, il est nécessaire de fournir aux décideurs des messages succincts mais informatifs, ce qui a eu pour résultat la mise au point de différents «indicateurs» pouvant être utiles à cette fin. Si les données mondiales sur l'état des ressources zoogénétiques sont disponibles dans un certain nombre de publications, la question de la mise au point d'un indicateur mondial pour les ressources zoogénétiques n'a gagné de l'importance que dans ces derniers temps. Le présent document décrit le contexte politique à la base de ces développements et examine les initiatives relatives à la mise au point d'indicateurs pour les ressources zoogénétiques aux niveaux national et régional. En outre, il expose brièvement quelques-unes des questions soulevées lors d'une réunion d'experts organisée par la FAO au mois de janvier 2010. A ce jour, la mise au point d'indicateurs pour les ressources zoogénétiques est limitée à l'Europe. Au plan mondial, les options sont restreintes en raison de la disponibilité limitée des données. Les experts, lors de la réunion, ont privilégié un ensemble d'indicateurs décrivant l'abondance relative des races indigènes par rapport aux races non indigènes et résumant l'état de danger des races. Le premier indicateur aura besoin d'un nouveau système de classification des races qui soit acceptable pour les pays et applicable dans le monde entier. Les catégories de l'état de danger d'environ 64 pour cent des races signalées sont disponibles dans le Système d'information sur la diversité des animaux domestiques, mais la carence de mises à jour régulières des données relatives aux populations raciales des pays fait en sorte qu'à présent, on n'est pas en mesure de décrire les tendances de façon adéquate.

Mots-clés: *Indicateur, diversité génétique, animaux domestiques*

Resumen
La necesidad de proporcionar a los responsables del diseño de políticas, a nivel informativo, mensajes está muy extendido en la gestión de la biodiversidad, y han llevado al desarrollo de varios "indicadores" que pueden servir para este propósito. Mientras los datos mundiales sobre la situación de los recursos zoogenéticos (AnGR por sus siglas en inglés) han hecho posible que se disponga de una serie de publicaciones, la cuestión del desarrollo de un indicador global para los AnGR ha llegado a ser relevante hace relativamente poco tiempo. Este trabajo describe el contexto político de estas medidas y la revisión de iniciativas en el desarrollo de indicadores para los AnGR a nivel nacional y regional. También se describen algunas de las cuestiones planteadas en una reunión de expertos sobre indicadores organizada por la FAO en enero de 2010. Hasta la fecha, el desarrollo del indicador para los AnGR ha sido en gran parte limitado a Europa. A nivel mundial, las opciones son restringidas debido a la limitada disponibilidad de datos. La reunión de expertos estuvo a favor de un conjunto de indicadores que describen tanto la relativa cantidad de razas locales frente a las foráneas y resume la situación de riesgo en las razas. Primero será necesario un nuevo sistema para la clasificación de las razas que sea admisible por los países y aplicable mundialmente. Las categorías acerca del nivel de riesgo de extinción de aproximadamente el 64 por ciento de las razas notificadas están disponibles en el Sistema de Información sobre la Diversidad de los Animales Domésticos, pero la falta de

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actualizaciones de manera regular acerca de los datos relativos a las poblaciones raciales hacen que las tendencias no puedan ser descritas adecuadamente en la actualidad.

Palabras clave: *indicador, diversidad genética, animales domesticados*

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Introduction

The most recent evaluation of the status of animal genetic resources for food and agriculture (AnGR) globally showed that 9 percent of the breeds reported to Food and Agriculture Organization of the United Nations (FAO) were already extinct and 21 percent were classified as at risk (FAO, 2009b). A further 36 percent of breeds had an unknown risk status, because of a lack of population data (ibid.). Given the multiple roles and values of AnGR and their contribution to food security, livelihoods, rural development, and to the cultural, social and religious fabrics of rural societies, the erosion of these resources requires urgent action. The importance of maintaining livestock diversity is underlined in the *Global Plan of Action for Animal Genetic Resources* (GPA), adopted by the member countries of FAO in 2007 (FAO, 2007b).

Actions to reduce or halt the erosion of AnGR need to be well targeted and their outcomes evaluated. To these ends, it is important that the status and trends of AnGR diversity be monitored effectively. It is also important that the outputs of monitoring processes be made available in forms that are easily understood and easily assimilated into decision-making processes. The need to provide policy-makers with succinct, yet informative, messages about complex problems is widespread in the field of biodiversity management and much effort has been dedicated to the development of the so-called "indicators" – measures of biodiversity or related phenomena – that can serve this purpose. This paper focuses on the uses of indicators in the field of AnGR management: reviewing previous and ongoing initiatives and discussing potential future developments particularly at the global level.

Work on indicators under the Convention of Biological Diversity and the Commission on Genetic Resources for Food and Agriculture

While global data on the diversity of AnGR and the risk status of these resources have been collated and published in a number of publications over a substantial period (FAO/UNEP, 1993, 1995, 2000; FAO, 2007a), the specific issue of developing a global indicator (or indicators) for AnGR has come to prominence more recently. The current focus on indicators is the outcome of a series of developments in the intergovernmental fora that address the management of biodiversity and genetic resources for food and agriculture.

As early as 1995, Parties to the Convention of Biological Diversity (CBD) began discussing the need to develop indicators to describe changes in the state and trends of biological diversity as well as progress in the implementation of the CBD at national, regional and global levels. The need for indicators became more urgent following the adoption of the Strategic Plan of the CBD in 2002 and its 2010 Biodiversity Target "to significantly reduce the current rate of biodiversity loss at the global, regional and national level" (CBD, 2002). Work on indicators was therefore stepped up. It was concluded that because of the complexity of biodiversity, incomplete taxonomic knowledge and the high costs of assessments, most biodiversity monitoring should be based on a small number of indicators for which data are available or could be acquired in a cost-effective manner. This practical approach led Parties to endorse, at the Seventh Conference of the Parties to the CBD (COP) in 2004, a limited number of trial indicators to be used to assess global progress towards the 2010 Biodiversity Target and to communicate trends in biodiversity related to the three objectives of the Convention (Decision VII/30, CBD, 2004). At the following COP, held in 2006, Parties established institutional responsibilities for finalizing potential indicators (Annexure V of decision VIII/15; CBD, 2006). FAO was given responsibility for coordinating the delivery of all indicators describing trends in major components of agricultural genetic diversity (genetic resources for food and agriculture).

The process of indicator development was given added impetus by the establishment of the 2010 Biodiversity Indicators Project[1] (acknowledged by COP Decision VIII/15). The project includes a component (in which FAO is the "key partner") that addresses indicator development in the field of "genetic diversity of terrestrial domesticate animals", which falls under the CBD headline indicator "trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socioeconomic importance".

In parallel to developments at the CBD, the GPA was endorsed by the 2007 FAO Conference. The GPA notes that it will be necessary periodically to assess the status and trends of AnGR and that "the Commission on Genetic Resources for Food and Agriculture should regularly receive, from countries, status and trends reports on

[1] http://www.twentyten.net/

national animal genetic resources and factors influencing change, in order to review progress and further develop country-based early-warning and response systems for animal genetic resources" (FAO, 2007b, 2007d). As a follow-up, the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA), at its 11th Regular Session, requested that the Intergovernmental Technical Working Group on Animal Genetic Resources (ITWG-AnGR) provide recommendations on the form and content of future status and trends reports on AnGR and options for responding to the identification of breeds at risk (FAO, 2007c). The recommendations of the ITWG-AnGR (FAO, 2009c) were adopted by the CGRFA at its 12th Regular Session in 2009 (FAO, 2009d). Table 1 shows the contents of the status and trends reports as agreed upon by the CGRFA. It can be seen that trends in genetic erosion were to be described, in line with the previous global assessment presented in *The State of the World's Animal Genetic Resources for Food and Agriculture* (FAO, 2007a), in terms of changes in the risk status of breeds reported to the Domestic Animal Diversity Information System (DAD-IS). It is well recognized that breed risk-status figures do not provide a full picture of the state of genetic diversity. They do not account for the fact that some breeds are genetically more diverse than others or for the effects of genetic dilution caused by uncontrolled cross-breeding (FAO, 2007a). The risk-status trend figures were to be complemented by the (as yet undefined) CBD headline indicator once it became available.

The background to recent efforts to develop AnGR indicators is therefore: a mandate from the CBD for the development of an indicator of "trends in genetic diversity"; a mandate from the CGRFA for this indicator to be included in biennial status and trends reports on AnGR; and an absence of mechanisms to monitor genetic diversity *per se* as opposed to proxies based on the risk status of breed populations.

What is an indicator?

According to OECD (2003b), an indicator is a parameter or a value derived from parameters that points to, provides information about or describes the state of a phenomenon/environment/area and that has significance that extends beyond that directly associated with a parameter value. Indicators should serve four basic functions: simplification, quantification, standardization and communication. They summarize complex and often disparate sets of data. They should be based on comparable scientific observations or statistical measures, and be developed using standardized methodology. They should also provide a clear message that can be communicated to, and used by, decision-makers and the general public (CBD, 2003c). Baldi (2001) offers the following definition: "An indicator can be defined as something that helps us to understand where we are, where we are going and how far we are from the goal. Therefore, it can be a sign, a number, a graphic and so on. It must be a clue, a symptom, a pointer to something that is changing. Indicators are presentations of measurements. They are bits of information that summarize the characteristics of systems or highlight what is happening in a system".

Indicators can be single parameters, sets of individual parameters presented together or indices constructed using several parameters. They can be used at various levels: local, national, regional and international. At the local level, indicators are often used for research purposes or

Table 1. The format and content of future status and trends reports.

Area	Elements of the reporting
The state of reporting	• Status of information recorded in the Global Databank for Animal Genetic Resources: the number of national breed populations (mammalian and avian) and the proportion of breeds for which population data are recorded
Breed diversity	• Global number of mammalian and avian breeds (local, regional transboundary and international transboundary)
	• Number of mammalian and avian breeds (local, regional transboundary and international transboundary) by region
	• Number of mammalian local breeds by species and region
	• Number of avian local breeds by species and region
	• Number of mammalian regional transboundary breeds by species and region
	• Number of avian regional transboundary breeds by species and region
	• Number of mammalian international transboundary breeds
	• Number of avian international transboundary breeds
Risk status of animal genetic resources	• Proportion of the world's breeds (mammalian and avian) by risk status category
	• Risk status of the world's mammalian breeds by species
	• Risk status of the world's avian breeds by species
	• Risk status of the world's mammalian breed by region
	• Risk status of the world's avian breeds by region
	• Number of extinct mammalian breeds
	• Number of extinct avian breeds
	• Years when breeds became extinct
Trends in breed status	• Changes in the numbers of local, regional and international breeds since the last status and trends report
Trends in genetic erosion	• Changes in the risk status of transboundary breeds since the last status and trends report
	• Changes in the risk status of local breeds since the last status and trends report
	• When [it] becomes available: changes in the headline indicator

Source: FAO (2009a).

to monitor changes in specific habitats and ecosystems and provide an assessment of various aspects of the local environment. At the national level, indicators are important for planning, policy development and programme priority setting, as well as for raising awareness (OECD, 2003b). At the international level, indicators are used to describe the state of the environment and progress towards environmental goals, either regionally or globally.

The objective of using biodiversity indicators is often to build a bridge between policy-making and science. The role of policy-makers is to create a vision, a set of objectives and measurable targets. The task of scientists is to identify relevant biodiversity variables and develop models and tools that will support monitoring of the current state of biodiversity and projections of future trends. These two dimensions are not easy to merge (Levrel, 2007). The policy dimension requires indicators that are comprehensible to a large non-expert audience. Conversely, to the scientist, an indicator must be methodologically sound and amenable to unambiguous interpretation.

What makes a good indicator?

Various criteria for evaluating the quality of potential indicators have been proposed. OECD (1993) lists the following three key quality criteria: political relevance and utility for users; analytical soundness/robustness; and measurability. According to CBD (2003a, 2003c), indicator sets should recognize the target audiences, and should be ecosystem and policy relevant, simple and easily understood, quantitative, scientifically credible, normative (allowing comparison with a baseline situation and policy target), responsive to changes in time and space, cost effective and unambiguously useable for future projections, allowing aggregation at the level of ecosystem/habitat types or nationally and possibly internationally. The CBD's Subsidiary Body on Scientific, Technical and Technological Advice, at its ninth meeting, decided on seven principles for choosing and evaluating indicators (CBD, 2003a) – indicators should

- be policy relevant and meaningful (provide clear messages at appropriate levels);
- be biodiversity relevant;
- be scientifically sound;
- have broad acceptance;
- enable affordable monitoring;
- enable affordable modelling;
- be sufficiently sensitive, i.e. they should be able to show trends and, where possible, permit distinction between human-induced and natural changes. They should not only be able to detect changes in systems in relevant time frames and scales but also be sufficiently robust so that measuring errors do not affect their interpretation.

A set of indicators should preferably be small in number, in order to be more easily communicable to policy-makers and the public, and to lower the costs involved. Indicators should be designed in a manner that facilitates aggregation at a range of scales. Aggregation at the level of ecosystem types or at national or international levels requires the use of coherent indicator sets and consistent baselines (CBD, 2003a).

What can we learn from previous initiatives?

The indicator concept has been used more widely in the field of wildlife biodiversity than in AnGR management. The most often used biodiversity indicator is species richness, which is the number of species present in a given area (ecosystem, country, etc.) or in the biosphere as a whole (Levrel, 2007). Species diversity, however, comprises not only the number of species but also their relative abundance; i.e. a population that is dominated by a few, very common, species is less diverse than one in which the species abundance is more equally distributed (ibid.). Indices such as those of Shannon and Simpson combine species richness and relative abundance into a single figure (Shannon, 1948; Simpson, 1949). As an indicator of trends in the state of biodiversity, species richness is rather inadequate. Richness only falls when one or more species become extinct. Relative abundance is a more sensitive indicator. A change in relative abundance is often a sign that an ecosystem has been disturbed in some way (e.g. as a result of overharvesting or pollution). Clearly, substantial declines in the abundance of individual species are also a matter of concern; they indicate that if trends continue, the species in question may face extinction and that the overall diversity of the population will decline. Many species-level indicators of wild biodiversity are calculated on the basis of trends in the abundance of a set of species. Examples include the living planet index, the wild bird index and mean species abundance (MSA; see further discussion below). Red list indices are calculated based on the number of species falling into risk-status categories, assigned on the basis of their abundance, distribution and trends (Butchart *et al.*, 2004). Indicators of wild biodiversity include descriptors not only of species diversity but also of ecosystem diversity. Ecosystem-level indicators normally focus on the extent of particular habitats, such as forests, mangroves or coral reefs. Genetic diversity within wild species generally receives little attention in terms of indicator development (Laikre *et al.*, 2010).

Although, as described above, breed diversity does not adequately reflect the underlying genetic diversity in a livestock population, the breed is commonly the unit in which AnGR diversity is discussed. It is generally accepted that the extinction of a breed represents an unwelcome loss of genetic options for the future, as does the loss of within-breed genetic diversity that occurs when breed populations decline to low levels or experience increased inbreeding levels owing to the excessive use of a limited number of sires. Indicators based on richness, abundance and extinction risk at breed level present a clear message that potentially valuable resources are being, or are in

danger of being, lost. The status and trends of AnGR have often been described in such terms (FAO, 2009a and other examples described below). Indicators that incorporate the concept of relative abundance signal that the composition of the population is changing, but do not provide such an unambiguous message to policy-makers as those that are based on risk status. While a more even pattern of breed abundance may be desirable in some respects, it is not clear that a livestock population that is becoming less even in its breed composition is necessarily being mismanaged. It is still less clear that maximizing a specific index such as that of Shannon or Simpson is an appropriate objective.

In the environmental field, many indicators have been developed within the Pressure-State-Response framework (OECD, 1993, 2003a, 2003b). This framework distinguishes three types of indicators: pressure indicators, which describe pressures imposed on the environment by human activities; state indicators, which describe the current quality or condition of the environment; and response indicators, which describe responses to environmental changes and concerns. A more detailed framework, Driving force–Pressure–State–Impact–Response, has been used in various projects that have developed environmental indicators (EEA, 1999; EC, 2000). The definitions used to describe the various elements of these frameworks are not always appropriate to the AnGR context. However, the basic distinction between pressures, states and responses may be useful. Indicators of the "state" of genetic diversity (or proxies such as breed diversity and risk status) might be complemented by indicators of "pressure" (e.g. extent of economic growth and market integration; extensification, intensification or homogenization of production systems; utilization of modern technologies; or the number of breeding goals) and indicators of response (e.g. the state of conservation programmes or the implementation of measures to support the sustainable use of AnGR).

Since the late 1990s, a number of international organizations have been actively engaged in developing biodiversity indicators covering a range of issues including agricultural impacts on soil, water, air, biodiversity, habitats and landscapes. Key contributors to the development of agrobiodiversity indicators include the Organisation for Economic Co-operation and Development (OECD) (OECD, 1999a, 1999b, 2001, 2008); the European Topic Centre on Biological Diversity of the European Environment Agency (EEA) (EEA, 2005, 2007, 2009a, 2009b); the European Regional Focal Point for Animal Genetic Resources (Charvolin, 2007, 2008); and the United Nations Environment Programme's World Conservation Monitoring Centre (Bubb, Jenkins and Kapos, 2005). There have also been project-based initiatives such as Global Methodology for Mapping Human Impacts on the Biosphere (GLOBIO) (Alkemade *et al.*, 2009; www.globio.info), and research undertaken by the scientific community.

In the field of AnGR diversity, major inputs were provided by the Institute of Organic Agriculture, University of Bonn, Germany (Wetterich, 2003); Wageningen University and the Centre for Genetic Resources in the Netherlands (Eaton *et al.*, 2006; Hiemstra *et al.*, 2006; Buiteveld *et al.*, 2009); and Scottish Agricultural College and Roslin Institute, United Kingdom (Villanueva *et al.*, 2009a, 2009b). This work that focused specifically on indicator development had been preceded, not only by the earliest of the above-mentioned global assessments of AnGR diversity but also by a number of regional initiatives in the assessment of the state and trends of AnGR in Europe. The first such assessment was initiated across Europe in 1980 (Maijala *et al.*, 1984) stimulated by the FAO/UNEP Technical Consultation on AnGR Conservation and Management (FAO, 1981). The Working Group on AnGR of the Commission on Animal Genetics of the European Association for Animal Production, organized in 1982, 1985 and 1988, three successive surveys on European livestock breeds of cattle, sheep, goats and pigs, with the participation of 22, 17 and 12 countries, respectively (Simon and Buchenauer, 1993). The European Animal Genetic Data Bank (AGDB) at Hannover Veterinary University (TIHO) was established during the 1980s.

In 2001, the OECD proposed the following set of indicators to monitor the diversity of crop varieties and livestock used in agricultural production (OECD, 2001):

1. For the main crop/livestock categories (e.g. wheat, rice, cattle and pigs) the total number of crop varieties/livestock breeds that have been registered and certified for marketing.
2. The share of key crop varieties in total marketed production for individual crops (e.g. wheat, rice and rapeseed).
3. The share of the key livestock breeds[2] in respective categories of livestock numbers (e.g. the share of Friesian, Jersey, Charolais in total cattle numbers).
4. The number of national crop varieties/livestock breeds that are endangered.

This indicator set in theory provides quite a comprehensive description of the state of breed diversity. For each livestock species covered, it includes a measure of breed richness, a measure of relative abundance and a summary measure of the abundance of individual breeds. However, a few problems should be noted. With respect to the breed richness figures, apart from the possibility that they change simply because of changing rules and procedures for registering and certifying breeds, there is no means of distinguishing changes that arise because of imports of new breeds from abroad (or abandonment of efforts to introduce a new breed) from changes to the existing "native" population (e.g. extinctions). The abundance

[2] The indicator was in fact calculated on the basis of the *three* most common breeds. This detail was included in the revised version of the indicators (OECD, 2008).

of the three commonest breeds relative to the whole population gives some indication of the homogeneity of the population in terms of its breed composition. However, it should be recalled that the relative abundance of breeds in a national population is likely to be affected by the relative extent of the production systems and environments to which they are adapted, which in turn is affected, *inter alia*, by the significance of industrial production systems and the diversity of the country's geography. There is no "ideal" breed rank abundance curve that is appropriate for all countries. The indicator is also vulnerable to gaps or inconsistencies in the reporting of population figures (e.g. how cross-breeds are accounted for) and does not reveal whether the three dominant breeds are native or non-native. Finally, no basis for estimating the endangerment status was specified by the OECD. Some of these problems were recognized by Wetterich (2003) who proposed that OECD indicators 1 and 3 be modified in order to allow native breeds to be distinguished from non-native breeds, indicator 4 should cover native breeds and endangerment status classification should be standardized based on the work of Bodó (1992). Wetterich (2003) also proposed two additional indicators, as follows:

1. *Frequency of application of high-selective breeding methods in the species concerned*. The argument for including this indicator is based on the assumption that artificial insemination and embryo transfer will, respectively, decrease the number of sires or parents of successive generations, and therefore will lead to a reduction of within-breed diversity. This effect has, indeed, been observed especially in high-performing international transboundary breeds. However, if the application of modern reproduction methods is evaluated only at the species level, it will not reflect the situation of particular breeds. Moreover, it is doubtful whether hybrid breeding in pigs should be included in the calculations (ibid.), as this aspect of breeding is purely commercial and terminal and, as such, the animals do not contribute to future pure-bred populations. It should also be noted that this indicator is in conflict with credible strategies for genetic improvement and germplasm utilization.
2. *Number of breeders' associations.* The argument for including this indicator is based on the assumption that each association manages its own breeding programme, and therefore the number of officially accredited breeders' associations within a given species provides a measure of the number of independent breeding populations and breeding schemes. If this is the case, a decline in the number of breeders' associations implies that populations are being merged and that common breeding goals and higher selection intensity are being applied, with the long-term consequence that the risk of genetic erosion increases. This indicator may work well for some countries (e.g. Germany) but will not necessarily enable similar conclusions to be drawn in other countries. Not all breeders' associations are organized at the breed level. Sometimes they have regional structures and provide services to all breeders of a particular species or sector of production (e.g. dairy or beef) regardless of the specific breed they keep. New breeding organizations may be established following the import of exotic breeds. Moreover, a single breeding organization can ensure that a breed is bred in a sustainable way and that within-breed genetic diversity is maintained: the Norwegian Red cattle breed is an example (FAO, 2007a). A modified version of this indicator, such as "number of breeds represented by a breeders' organization" or "share of breeds represented by a breeders' organization," might be more widely applicable.

The distinction between native and non-native breeds has been included in a number of proposed indicators (see further examples below). Several distinct motives for this inclusion can be identified. As mentioned above, it prevents indicators based on national trends in breed richness from being distorted by imports. Moreover, Wetterich (2003) argues that countries have a greater responsibility for ensuring that their native breeds do not become extinct than for ensuring the survival of breeds from elsewhere. A less prescriptive way of putting this is that countries are more likely to be concerned about, and take responsibility for, breeds that are locally adapted and/or considered a part of their national heritage (although the costs involved may mean that this is not the case everywhere). Countries may therefore be interested in having indicators that allow these breeds to be distinguished. From an international perspective, the decline of breeds in their native countries shows that the breeds are no longer thriving "*in situ*" in their production systems of origin and in the countries where they are most likely to be valued and conserved. An additional argument is that the diversity of the native breed population can be expected to be more genetically diverse than the non-native, which will usually be dominated by a limited number of intensively selected breeds. Finally, it can be argued that the balance between native and non-native breeds is an indicator of the extent of a country's self-sufficiency in meeting its needs for AnGR.

The IRENA operation (Indicator Reporting on the Integration of Environmental Concerns into Agriculture Policy) coordinated by the EEA, aimed to further develop agri-environmental indicators for monitoring the integration of environmental concerns into the Common Agricultural Policy of the European Union (EU) (EEA, 2005). The operation, conducted between 2002 and 2005, led to the development of a set of 35 indicators, which included two indicators related to biodiversity and one addressing genetic diversity. The latter was defined as the number and range of crop varieties and livestock breeds and was divided into three subindicators, two of which focused on animals (IRENA, 2002):

- IRENA 25-2: Diversity of breeds in the total livestock population for different types of livestock (cattle, pigs, sheep, goats and poultry).

- IRENA 25-3: Distribution of the risk status of national livestock breeds in agriculture.

Breed diversity (IRENA 25-2) was calculated as the number of breeds divided by the total livestock population for the main livestock categories (cattle, pigs, sheep, goats and poultry) that are registered in the herd-books in individual EU countries and reported to FAO. A problem with this indicator is that if the total species population falls, "diversity" will appear to rise even if many breeds have slipped towards extinction. It is also based on the assumption that herd books and breeding societies are in place for each breed. The IRENA 25-3 indicator summarized the risk status of national livestock breeds for the main livestock categories. It was estimated using national data included in DAD-IS in July 2003. The indicator utilized only the three following categories: (1) extinct; (2) endangered or critical; and (3) not at risk or unknown. This approach was too simplistic: in particular, combining breeds categorized as not at risk and breeds with no population data was likely to lead to misleading conclusions.

To ensure a coherent approach to the development of indicators at the European level, the EU launched the SEBI2010 project (Streamlining European 2010 Biodiversity Indicators) (EEA, 2007). This Pan-European initiative aimed to develop a European set of biodiversity indicators to assess and provide information on progress towards the European 2010 target to halt biodiversity loss (SEBI2010, 2009a, 2009b, 2009c). The project resulted in the establishment of a set of 26 indicators, nested within seven focal areas (EEA, 2007). Within the focal area: "Status and trends of the components of biological diversity", the indicator of "livestock genetic diversity" was defined as "the share of breeding female population between introduced and native breed species (namely, cattle and sheep) per country, as a proxy to assess the genetic diversity of these species".

The indicator also shows the proportion of native breeds that are endangered due to the low number of breeding females (EEA, 2007). Definitions of endangerment levels and native versus non-native breed status are based on countries' own criteria (i.e. are not consistently defined across all countries). Initial calculations of this indicator were based on existing data for 1995, 2000 and 2005 (±2 years). The indicator was calculated for cattle and sheep only.

As described above, there are several reasons why distinguishing native from non-native breeds may be useful. Nonetheless, the share of population made up of native breeds does not, in itself, indicate very clearly whether or not there is actually a significant problem of diversity loss that needs to be addressed. The practical impact of this element of the indicator as a guide for policy-makers can particularly be questioned in circumstances where increasing the proportion of non-native breeds in the national population is the most feasible means of meeting the rising demand for animal products.

In contrast, the other element of the indicator – proportion of native breeds that are endangered – does indicate the presence of specific problems. However, the indicator requires that good risk-status statistics are available, which globally is not yet the case. Moreover, it is not necessarily a good indicator of progress, because if a breed becomes extinct, the percentage of the endangered breeds will go down and the indicator will show a positive trend. The latter problem might be addressed by adding an additional category: "proportion of native breeds that are extinct".

Two studies conducted by a team from the Centre for Genetic Resources (CGN) and Wageningen University, the Netherlands, in collaboration with partners from Viet Nam, built on the above-described OECD and Wetterich indicators and developed and tested further sets of indicators (Eaton *et al.*, 2006; Hiemstra *et al.*, 2006). The extended and restricted sets of indicators that emerged from these studies are shown in Table 2. Having tested these new indicator sets and a number of already available sets (CBD, OECD, Wetterich) against four OECD evaluation criteria: policy relevance, analytical soundness, measurability and interpretation, the authors of these studies concluded that no single set of indicators had outstanding overall scores in comparison with the others. In other words, the conclusion was that there would be trade-offs between certain aspects of indicator quality and feasibility in use. One thing to note about the lists of indicators shown in Table 2 is that they include not only indicators of the "state" of diversity (richness, relative abundance, risk status, etc.) but also some indicators that describe the production environment (farm size, etc.), and some that describe the state of responses to the loss of diversity (e.g. the quantity and quality of conservation programmes).

Another study carried out by the CGN in cooperation with the Netherlands Environmental Assessment Agency was part of a project aiming to widen the analytical scope of GLOBIO3 – Modelling Global Biodiversity (Buiteveld *et al.*, 2009). The objective of this project was to identify a number of key biodiversity indicators for crops and livestock, with the ultimate goal of using them in modelling global trends and possible changes in agrobiodiversity. Case studies were undertaken to test selected indicators using data from the Netherlands and Germany. The main novelty in this study was the use of an indicator referred to as mean variety abundance (MVA) which had been suggested by Hiemstra (2007; cited in Buiteveld *et al.*, 2009). MVA is an adaptation of MSA, which is used as an indicator in the field of wild biodiversity (Alkemade *et al.*, 2006). The distinctive feature of MSA is that it compares current biodiversity with the state of biodiversity at a point in the past considered to represent a "natural" or low impacted state. "Exotic" species, which were not present in the natural state, are not included in the calculations. Similarly, the MVA as applied to livestock breeds is based on the abundance of native breeds relative to their original abundance. The baseline could, for example, be

Table 2. Sets of indicators proposed by Eaton *et al.* (2006) and Hiemstra *et al.* (2006).

Extended set (Eaton *et al.*, 2006)	**Extended set (Hiemstra *et al.*, 2006)**
1. Average size of farm*** • Area in hectare • Number of animals • Animals per hectare	1. Number of key livestock breeds (native endangered, native not-endangered and non-native)
2. Number of key livestock breeds* • Native endangered • Native not-endangered • Non-native	2. Share of the three major livestock breeds
3. Share of the three major livestock breeds* • Native/non-native* • Number of breeding males of the three major (high production) breeds***	3. Native breeds (population size, status of endangerment *in situ* conservation)
4. Population size of native breeds: • Status of endangerment* • Number of conserved *in situ****	4. *Ex situ* conservation (number of breeds conserved, number of accessions characterized)
5. Number of breeds conserved *ex situ****	5. Intensification and use of modern breeding strategies and high-selective breeding methods (such as embryo transfer)
6. Number of accession characterized***	6. Average size of farms (area in ha, number of animals, animals/ha)
7. Intensification and use of modern breeding strategies***	7. Number of breeders/ breeders associations per breed
8. Number of breeding males of breeds characteristic for landscapes or production environment important for biodiversity and characteristic for a region or country***	8. Number of different breeding goals
9. Number of breeders/breeders associations per breed**	
10. Number of breeding goals***	
Restricted set (Eaton *et al.*, 2006)	**Restricted set** (Hiemstra *et al.*, 2006)
Number of breeding males of breeds characteristic for landscapes/ production environments important for biodiversity and/or characteristic for a region or country	Number of breeding males of breeds characteristic for landscapes/ production environments important for biodiversity and/or characteristic for a region or country
Number of breeding organizations of high-production breeds	*Number of breeding males of the three major (high production) breeds*
Number of breeding males in gene bank(s) of characteristic (low production) breeds	Number of breeding males in gene bank(s) of characteristic breeds

Note: the asterisks indicate the original proposers of the respective indicators: * = OECD (2001/2003a); ** = Wetterich (2003); *** = Eaton *et al.* (2006); *** = Hiemstra *et al.* (2006).

1950 ("pre-intensification times") (Buiteveld *et al.*, 2009) or 1850 ("pre-industrial times") (CBD, 2003b). One practical advantage of this indicator is that it is based on a fixed set of breeds. Therefore, trends cannot be distorted by the import of additional breeds from outside or by a reclassification of breeds between categories, as can happen with breed richness-based indicators and those that classify breeds according to their current distribution. Conversely, the indicator provides no information about the diversity of recently introduced breeds (commonly the high-output transboundary breeds). The indicator is also very demanding in terms of the baseline data required: i.e. an accurate description of the state of the population at some quite distant point in the past. For the countries covered by the Buiteveld *et al.* (2009) study, a baseline around 1950 captured the beginning of a period of rapid intensification and technological innovations, such as artificial insemination. The assumption was that before 1950 only local breeds were kept. The pre-industrial baseline (1850) proposed by the CBD would refer to the state of traditional agriculture before industrialization (CBD, 2003b).

Further work on indicators has been carried out by the UK Biodiversity Partnership, which in 2007 agreed on 18 indicators and 33 component measures to summarize some of the key priorities for biodiversity in the United Kingdom. One of these indicators addresses genetic diversity in native sheep and cattle breeds (Defra, 2009b). Within-breed genetic diversity is described in terms of the effective population size (N_e). The indicator was defined as the species average population size (N_e) for the lower tail (20 percent) of the distribution of N_e across breeds. The strengths of this indicator include the fact that it addresses genetic variation within breeds and focuses on the breeds that are most at risk (Villanueva *et al.*, 2009a, 2009b). The evaluation covered the period from 2001 to 2007. The results were presented in a graphic form that was easy to communicate to the public (Defra, 2009a). The application of such an indicator is dependent on the availability of the relevant data. In the United Kingdom, the relevant data were obtained for 53 percent of sheep breeds and 58 percent of cattle breeds considered to be native to the country. The figures were calculated on the basis of pedigree data for individual animals or, in the case of breeds where these data were not available, of the numbers of male and female breeding animals used each year, the numbers of years of active breeding for males and females, proportions of breeding males and

females remaining in the herd/flock from one year to the next and the number of offspring per dam surviving to breeding age (Villanueva *et al.*, 2009a).

In summary, initiatives in the development of indicators for AnGR diversity have largely been restricted to Europe and reflect the characteristics of AnGR management in this region. They all require that the animal population be assigned to distinct breeds: something that is relatively easy in Europe with its long tradition of breed societies, but which is far less so in many other parts of the world. Indicators that are based only on herd-book breeds, or breeds that are registered or certified, are even less feasible to implement globally. The same is true for indicators that require detailed pedigree data or detailed records of the past characteristics of livestock populations (while herd books and official statistics are not the only potential source of such data – local livestock keepers and breeders are often very knowledgeable – compiling regularly updated national indicators based on these alternative sources would be extremely challenging if not impossible). A further lesson is that indicators that involve classifying breeds need to be carefully defined if they are to meet the criterion of providing decision-makers with clear and unambiguous information. Problems may arise, for example, if indicators used for international summaries or comparisons are based on national statistics that use different definitions of risk status or native-breed status. Indicators of trends over time may be distorted if, for example, countries' rules allow for additional breeds to be added to the native category (e.g. breeds previously unrecognized by national authorities that are "discovered" among "non-descript" populations when breed surveys are conducted or composites of native breeds that newly meet the criteria for inclusion). Care is also needed to ensure that indicators are not unduly affected by other minor changes that may have little policy significance, such as the import of a small number of animals from exotic breeds that were previously not present in the country (increases total breed richness).

What data are available?

Plans for a global indicator have to take into account the constraints imposed by the limited availability of data on a global scale. At present, the only AnGR information system that has global coverage and includes a standardized set of fields for recording demographic data is DAD-IS (and associated FABISnet systems). The basic unit for recording demographic data in DAD-IS is the national breed population. If breed populations in different countries are considered to be part of a common gene pool, they are linked within the system and treated as part of a so-called "transboundary" breed. Breeds that are present in only one country are described as "local". The unit for supranational (regional or global) analyses is therefore the breed. It is possible to break such analyses down by distributional category (local vs. transboundary). However, it is important to understand that these categories were developed in order to avoid double-counting in global statistics, not as a means of distinguishing whether or not breeds are "native" or "locally adapted" to particular countries.

If DAD-IS is the source of data, it follows that a global indicator of genetic diversity will have to be based on the breed as a unit of analysis. The global indicator will therefore not solve the above-described problems, such as the absence of a method to describe the effects of indiscriminate cross-breeding or the difficulty involved in assigning many animal populations in developing countries to specific breeds.

The breed inventory available in DAD-IS allows basic breed richness statistics to be calculated at national, regional or global levels. However, indicators based on abundance or on risk status also require that the size (and preferably the structure) of the populations be recorded. In 2008, 48 percent of mammalian national breed populations and 53 percent of avian national breed populations recorded in DAD-IS had no population data recorded (Table 3). Only 64 percent of breeds could be assigned to a risk-status category (FAO, 2009b).

Indicators can only illustrate trends if the data on which they are based are recorded repeatedly over time. FAO initiated collecting breed data for some species in some countries in 1987 and on a world scale in 1991/1992 (FAO/UNEP, 1993). Countries are encouraged to update their breed population records frequently and to enter whatever "historical data" (population figures from earlier years) that they have available. Table 3 shows that the number of breeds and the number of population records has increased over the years, but Figure 1 shows that the number of breeds for which a time series of population data is available is very limited.

Issues and problems in developing a global indicator

An expert workshop on indicators took place in Rome in February 2010 with the objective of providing recommendations on livestock genetic diversity indicators. The workshop recognized the limitations of breed-based analysis, but also that there was no feasible alternative to basing the indicator on data from DAD-IS. A number of "candidate indicators" were discussed. The workshop decided that global indicators similar to the SEBI indicators described above (share of native and non-native breeds in national populations, complemented by a summary measure of breed risk status) would be desirable. However, it was recognized that the existing local versus transboundary breed classification in DAD-IS could not be used for this purpose (see the previous section). The workshop therefore recommended that a new native versus

Table 3. Status of information recorded in the Global Databank for Animal Genetic Resources.

Year of analysis	Mammalian species		Avian species		Countries covered
	Number of national breed populations	% with population data	Number of national breed populations	% with population data	
1993	2 719	53	–		131
1995	3 019	73	863	85	172
1999	5 330	63	1 049	77	172
2006	10 512	43	3 505	39	181
2008	10 550	52	3 450	47	181

Source: FAO (2009b).

non-native classification should be developed and implemented in DAD-IS. The workshop also decided that once a native versus non-native classification is available, it would be worthwhile calculating national breed richness figures for native breeds as a basic indicator of diversity.

The workshop considered the range of species that might be covered by the indicators. It was agreed that the following 14 species and groups of species should be included: asses, buffalo, cattle and yaks, camels, goats, horses, llamoids, pigs, rabbits, sheep, chickens, ducks, geese and turkeys: in total 13 mammalian and four avian species. Although it would involve producing a large number of different statistics, the workshop decided that separate indicators for each species are needed because of the diverse nature of the production and breeding systems under which different species are kept.

A number of problems have to be resolved before the suggested indicator set can be implemented. Apart from the above-mentioned need to develop an additional breed classification system (which will have to be applicable globally and acceptable to the countries that supply DAD-IS data), an indicator based on the share of the population accounted for by native and non-native breeds requires a complete set of population data (all breeds). Missing data for a single abundant breed could heavily distort a country's indicators. It was proposed that the problem be addressed by adding a third population category to cover animals that do not belong to a breed for which population data are available in DAD-IS. See Figure 2 for an example of how the indicator could be presented in graphical form. The number of animals in the "unknown" category obviously cannot be obtained from DAD-IS. However, it may be possible to calculate this figure indirectly by subtracting the number of known native and non-native animals from the total population size for the respective species recorded in FAO's statistical database (FAOSTAT) for the relevant years. The feasibility of combining the two data sources needs to be evaluated before the indicator can be finalized. It will not be possible to calculate the indicator for species to which the categories in DAD-IS and FAOSTAT do not correspond.

The main practical problem associated with an indicator based on risk-status figures is the lack of regular updating of population data in DAD-IS (Figure 1 and Table 2). The CGRFA has requested status and trends reports on AnGR every 2 years. However, without regular updates the

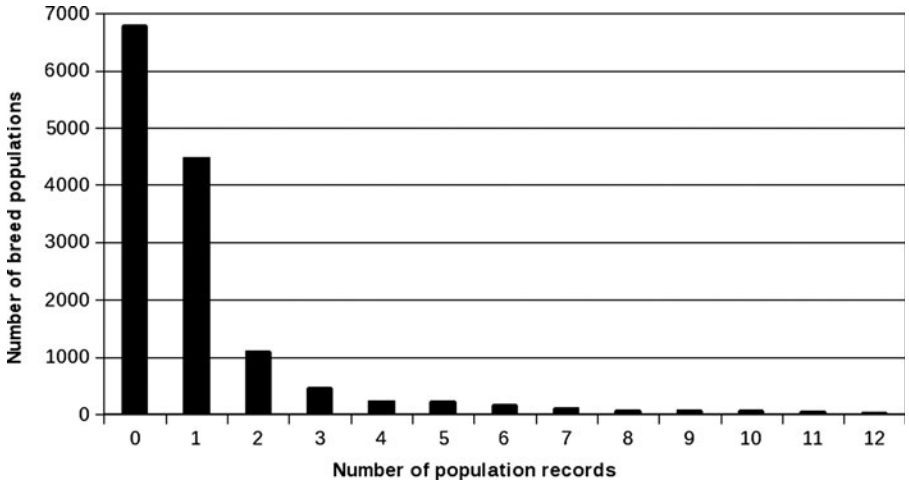

Figure 1. Number of population records available for the breeds recorded in DAD-IS.

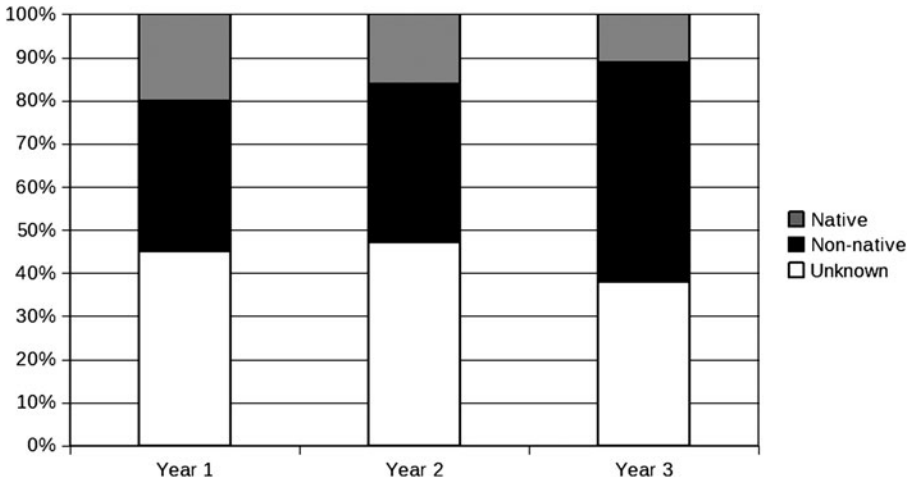

Figure 2. Illustration of the proposed indicator based on population share.

reports will be of little value. In fact they may give a false impression of stability in the status of AnGR or fail to indicate recent changes in the direction of trends. The workshop discussed the possibility of calculating trends based only on breeds for which a genuine trend can be calculated, i.e. for which two recent population figures have been reported (e.g. one within the last 2 years and another within the last 4 years). However, it was recognized that given the current rate of population-data updating in DAD-IS there would be little to report if such strict criteria were imposed. Another alternative considered was that after a given period of time (e.g. 10 years), if no new population data are reported, breeds should revert to "unknown" risk-status classification.

Conclusions

No global indicator for genetic diversity *per se* can be calculated at present. Development of a sound, a methodologically rigorous indicator of genetic diversity might require for instance a global estimate of an effective number of breeds in each species weighted by their within-breed diversity (based on the estimation of the N_e). However, with the information we have today it is a challenge that is impossible to meet and this is likely to remain the case for the foreseeable future.

It is possible to provide summaries of the risk statuses of breeds, and it may be feasible to describe the relative abundance of different categories of breeds (e.g. native and non-native). However, the usefulness of indicators based on these measures, would be affected by the large gaps that currently exist in the availability of data. Monitoring trends is even more problematic. Countries' updates of their breed population data in DAD-IS remain far too infrequent to allow global trends to be calculated accurately on the 2-year reporting cycle requested by the CGRFA.

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Motives and values in farming local cattle breeds in Europe: a survey on 15 breeds

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Summary
Within the EURECA project (Towards self-sustainable EUropean REgional CAttle breeds), we interviewed a total of 371 farmers of 15 local cattle breeds in eight European countries. Besides collecting data on farmers, land use, herd composition and economic role of cattle, we aimed at understanding farmers' motives and values in keeping local cattle. The most frequent first reason to keep the local breed was productivity, followed by tradition. When comparing the local breed with a mainstream breed, only in four breeds was productivity considered the same, while in three breeds more than 50 percent of farmers valued the local breed as more profitable. The local breed was valued as always superior or the same on functional traits. Farmers were asked which type of appreciation they thought representatives of various stakeholders had on their local breed: a positive appreciation was observed in 33 percent of farmers. On average across breeds, 39 percent of farmers expect to increase the size of their herd in the next few years and 5 percent plan to give up farming. The degree of dependence of farmers on economic incentives was estimated by asking farmers their expected behaviour under three scenarios of change of subsidies. Most farmers demanded activities for promoting local breed farming. The results are discussed in terms of breed sustainability and conservation.

Keywords: *animal genetic resources for food and agriculture, breed comparisons, breed values, conservation, local cattle*

Résumé
Dans le cadre du projet EURECA, nous avons interviewé au total 371 éleveurs de 15 races locales bovines dans huit pays européens. En plus de collecter des informations sur les éleveurs, leur exploitation, la composition du troupeau et l'importance économique des bovins, nous avons également cherché à comprendre les motivations des éleveurs à garder de telles races. La raison principale la plus fréquemment citée était la productivité, suivie par la tradition. Les races locales étaient aussi comparées aux races principales, dans seulement quatre cas la productivité était considérée comme équivalente, et dans trois races plus de 50% des éleveurs ont jugé leur race locale plus rentable. Pour les caractères fonctionnels, la race locale était toujours considérée supérieure ou égale. Nous avons aussi demandé aux éleveurs comment ils pensaient être vus par différentes parties prenantes concernant leur race locale: une appréciation positive a été indiquée par 33% des éleveurs. En moyenne, 39% des éleveurs envisagent d'augmenter leur cheptel dans les années à venir, 5% d'arrêter l'élevage. Le degré de dépendance des éleveurs vis-à-vis des subventions a été estimé en leurs demandant leur réaction face à trois scénarios de changement dans ces subventions. Beaucoup d'éleveurs sont demandeurs d'actions visant à promouvoir l'élevage des races locales. Les résultats sont discutés en termes d'élevage durable et de conservation.

Mots-clés: *ressources génétiques animales pour l'alimentation et l'agriculture, comparaison des races, valeurs des races, conservation, bovin local*

Resumen
371 ganaderos de 15 razas locales de 8 países Europeos se entrevistaron dentro del proyecto EURECA. Además de recoger datos sobre los ganaderos, el uso del terreno, la composición de las ganaderías, y su papel económico, buscamos entender los motivos por los que los ganaderos explotan estas razas y el valor que les dan. La razón principal más frecuente fue la productividad, siendo seguida por la tradición. Cuando los ganaderos compararon la raza local con la raza dominante, la productividad se consideró igual solo en cuatro razas y tres razas se consideraron más rentables por más del 50% de los ganaderos. Las características funcionales de estas razas fueron consideradas siempre iguales o superiores. Para el 33% de los ganaderos existe una apreciación positiva a sus razas por parte de distintos stakeholders. El 39% espera aumentar el tamaño de su ganadería en los próximos años mientras el 5% va a dejar la actividad.

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La dependencia a los subsidios se estimó explorando la reacción de los ganaderos ante tres escenarios de variaciones de las ayudas. La mayoría de los ganaderos reclamó actividades de promoción de la explotación de sus razas. Los resultados se discuten en términos de sostenibilidad y conservación.

Palabras clave: *recursos genéticos animales para la alimentación y la agricultura, comparación entre razas, valores de las razas, conservación, ganado vacuno autóctono*

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Introduction

The worldwide process of erosion of animal genetic resources for food and agriculture (AnGR) has been recently analysed by FAO (FAO, 2007); in Western Europe it started with the industrialization of agriculture after the Second World War, and more recently in Eastern and Central Europe countries it followed the political change and economic restructuring they underwent after the 1980s. The European Union recognizes the importance of conserving AnGR, and since 1992 started a policy of economic incentives for farmers keeping endangered breeds under ECRegulation 2078/92, followed by EC Regulation 1257/99. Despite the erosion during the last decades, Europe still hosts a large variety of local cattle breeds, although many are endangered (e.g. EFABIS, 2009).

In Europe, local cattle breeds are distributed across a wide variety of political, social, economical, cultural and environmental contexts. It is reasonable to think that this variety corresponds to a consistent diversity of farming structures, methods and motivations. In addition, both the erosion processes of the last decades and the more recent recovery processes observed in some breeds, driven by a variety of actions, possibly affected farming structure by creating additional variation within and between breeds. Thus, several questions can be posed: What kind of variation is present today among local cattle farming in Europe? What are the conditions affecting sustainability of local breed farming? Is it advisable to have common EC rules for conservation of local breeds? Can the current EC policy, based on payments of incentives – to compensate farmers for the lower profitability of the local breeds compared with substituting these breeds with more profitable mainstream breeds – and on some additional funds for applied research (GENRES, 2009), effectively contribute to AnGR conservation? The EURECA project – Towards self-sustainable EUropean REgional CAttle breeds – supported by the European Council (EURECA, 2009) was developed to contribute answers to these questions, and more generally to contribute methods and data that will be of value when new policies on farm animal genetic resources and rural development, as well as conservation programmes, are designed.

Within EURECA, this investigation aimed to understand the following: Who is today the farmer of the endangered local cattle breeds in Europe, what are the reasons for keeping local breeds instead of/besides mainstream ones, does the farmer feel understood or neglected by society, what kind of help would the farmer like to have, and what is the programme for the size of the herd in the next years? Farmers currently keeping local breeds are in a key position to guarantee sustainability of breeding, and for that reason it is necessary to understand their values and motives. This paper reports data collected by interviewing farmers of 15 European cattle breeds and proposes a first analysis of differences and similarities among breeds and countries. Other papers will investigate breed farming sustainability and will provide an analysis of strengths, weaknesses, opportunities and strengths (SWOT) to reach or maintain sustainability.

Material and methods

Farmers of 15 local cattle breeds, in the eight European countries partner of the EURECA project, were interviewed. Interviews were mostly conducted face to face during a farm visit, or by telephone or email. The questionnaire included: (i) questions related to background information on the interviewed farmer, his/her family, land use, production system and economic role of the farm; (ii) questions addressed to investigate farmers' perceptions on roles and values of the breed now and in the future, to understand farmers' perceptions on how the society values the breed; and (iii) questions aimed to analyse actions taken by the farmer in the past and expected in the future. A semi-structured questionnaire was used, including both structured and open-ended questions, for a total of 44 questions. This paper reports results on the 25 structured questions of the questionnaire.

Table 1 reports, by country, names of the 15 breeds analysed, breed codes used in the presentation of results, number of herds surveyed (i.e. farmers interviewed) per breed and degree of completeness of the questionnaires returned. One breed was analysed in Estonia (Estonian Native, code EEEN) and Ireland (Kerry, code IEKE), two breeds were analysed in Belgium (Dual Purpose Belgian Blue, code BEBM; Dual Purpose Red and White, code BEPR), Finland (Eastern Finn Cattle, code FNES; Western Finn Cattle, code FNWS), France (Ferrandaise, code FRFE; Villard de Lans, code FRVI), Italy (Modenese, code ITMO; Reggiana, code ITRE) and Spain (Avileña-Negra Ibérica, code EASN; Alistana-Sanabresa, code ESAS),

Table 1. Breeds surveyed by country, number of herds analysed and completeness of returned questionnaires.

Country	Breed	Breed code	No. of herds analysed	Completeness (%)	No. of cows	Trend
Belgium	Dual Purpose Belgian Blue	BEBM	23	92.9	4 400	S
	Dual Purpose Red and White	BEPR	18	84.2	3 000	D
Estonia	Estonian Native	EEEN	30	94.1	1 500	D
Finland	Eastern Finn Cattle	FNES	30	77.2	790	I
	Western Finn Cattle	FNWS	31	78.3	2 950	D
France	Ferrandaise	FRFE	19	94.7	730	I
	Villard de Lans	FRVI	15	88.9	340	S
Ireland	Kerry	IEKE	20	85.6	1 200	I
Italy	Modenese	ITMO	26	80.9	650	S
	Reggiana	ITRE	30	89.9	1 500	I
The Netherlands	Deep Red	NLDR	21	92.8	454	I
	Groningen White Headed	NLGW	22	92.0	1 500	S
	Meuse-Rhine-Yssel[1]	NLMR	24	83.5	14 400	D
Spain	Avileña-Negra Ibérica[1]	ESAN	31	83.7	100 000	S
	Alistana-Sanabresa	ESAS	31	84.2	2 000	I

Note: i, increasing; s, stable; d, decreasing. [1], breeds that, although are not endangered following EU criteria, after the 1950s experienced severe declines.

and three breeds in the Netherlands (Deep Red, code NLDR; Groningen White Headed, code NLGW; Meuse-Rhine- and Yssel, code NLMR). The set of 15 breeds surveyed across the eight countries was selected among those classified as endangered following EU criteria (5 000 or 7 500 cows, for breeds respectively numerically stable or declining; EC Regulations 1257/99 and 445/02) with the additional criteria of including breeds numerically declining, stable or increasing, except for two breeds above 7 500 cows, Avileña-Negra Ibérica and Meuse-Rhine-Yssel, that after the 1950s experienced severe declines. Breed sizes, as number of cows, and demographic trends are given in Table 1. All breeds are classified as dual purpose, but two are primarily dairy breeds (EEEN, ITRE) and two are beef breeds (EASN, ESAS).

We aimed to interview an equal number (30) of farmers per breed, representing from 5 to 75 percent of the herds of the breed. An average of 24.7 farmers per breed was interviewed, with a minimum of 15 to a maximum of 31, for a total of 371 farmers across the 15 breeds. Farmers were chosen at random. If the farmer community presented some specific structure with different typologies, then a stratified random sampling was used.

Across the 25 questions and the 15 breeds, the average level of responses was satisfactory (86.9 percent completeness), with some variation among breeds (range 84–95 percent) and questions. Analysis of variance and Pearson chi-square tests were used to compare the results across breeds (SAS, 2004).

Results and discussion

Tables 2–5 provide information on the farmers interviewed and their farms. Table 2 reports on farmers and their family. The average age of farmers across breeds is 48.7 years (SD 11.4), with some variation among and within breeds from a minimum of 43.3 years (SD 9.8) in FRFE to a maximum of 53.5 years (SD 14.6) in EEEN. Considering all breeds, most farmers (53.8 percent) have a middle education level, 29.2 percent have a basic education and 17.0 percent have a university education. Education level differs somehow among breeds. In four breeds, ESAS in Spain, FRFE in France, and ITMO and ITRE in Italy, the majority of farmers (from 43 to 70 percent) have a basic education. In the other ten breeds, the middle level is the most common, from 35 percent in IEKE to 83 percent in NLMR. In five breeds, the percentage of farmers with a university level is above 27 percent, up to a maximum of 36.7 percent (EEEN, ESAN). Information at the national levels is scarce and comparisons between farmers of mainstream breeds and our findings on local breeds are not possible. The age of the farmer provides indications on the process of transferring farming activities to the next generation and on opportunities for breed survival in the next few years. However, we did not ask farmers how they foresee the transfer of their farming activities. A recent survey in Belgium indicates that only 15.8 percent of farmers older than 50 years claim they have a presumed successor; 57.8 percent claim they have no successor and 26.4 percent do not know yet (DGARNE, 2009).

The average family size across breeds is 3.6 (SD 1.9) ranging from 2.4 (SD 0.9) in EEEN to 4.6 (SD 1.7) in NLGW. On average, 64.9 percent (SD 29.6) of family members contribute to farming activities, with some variation from 42.9 percent (SD 23.4) in ESAN to 89.7 percent (SD 19.4) in EEEN.

Table 3 reports data on land use. The average farm size across breeds is 151.3 ha (SD 15.8), 49.6 percent (SD 2.1) of property. Farm size ranges from 30.1 ha (SD 28.1) in NLDR to 760.7 ha (SD 633.9) in ESAN, and percentage of property ranges from 1.6 (SD 1.4) in IEKE to 80.9 (SD 17.9) in FNWS. The percentage of land used for grazing (Spanish data missing) across breeds is 48.0

Table 2. General data on the farmer and his family, by breed. Lower area, breed comparisons.

Country	Breed	*N*	Age of farmer (years)			Farmer's education level (%)			Family size			Workers of family (%)		
			Mean	SD	Range	Basic	Middle	University	Mean	SD	Range	Mean	SD	Range
Belgium	BEBM	23	47.2	11.29	29–63	4.4	82.7	13.0	4.1	1.56	2–7	75.4	27.48	20–100
	BEPR	18	51.9	10.64	38–75	5.6	88.8	5.6	3.2	1.40	1–6	61.6	30.93	20–100
Estonia	EEEN	30	53.5	14.60	17–72	10.0	53.3	36.7	2.4	0.86	1–4	89.7	19.44	50–100
Spain	ESAN	31	49.2	10.34	34–72	43.3	20.0	36.7	3.5	2.27	1–13	42.9	23.40	0–100
	ESAS	31	48.0	12.12	26–67	70.0	20.0	10.0	2.7	1.08	1–4	70.8	33.34	0–100
Finland	FNES	30	48.2	9.71	30–64	23.3	73.3	3.4	3.4	1.68	1–7	68.2	28.48	20–100
	FNWS	31	46.1	10.49	26–65	25.8	61.3	12.9	3.8	1.83	1–9	66.7	28.86	20–100
France	FRFE	19	43.3	9.75	25–61	45.4	27.3	27.3	2.9	1.37	1–5	65.9	32.66	20–100
	FRVI	15	45.5	10.18	29–61	14.3	71.4	14.3	3.9	1.58	1–7	43.9	25.32	14–100
Ireland	IEKE	20	50.9	11.51	27–78	35.0	35.0	30.0	3.6	1.93	1–9	75.1	30.48	20–100
Italy	ITMO	26	51.0	13.09	28–76	61.5	26.9	11.5	3.6	1.86	1–9	71.2	27.89	11–100
	ITRE	30	47.2	13.14	27–83	66.0	33.3	6.7	4.4	2.61	1–15	60.2	22.91	25–100
The Netherlands	NLDR	21	48.4	9.26	30–66	0.0	71.4	28.6	3.8	2.09	1–7	54.7	32.94	0–100
	NLGW	22	48.6	10.06	30–67	4.5	72.7	22.7	4.6	1.71	1–8	54.3	27.15	20–100
	NLMR	24	48.9	10.34	28–68	4.2	83.3	12.5	3.8	1.95	1–9	64.2	23.71	33–100
Total		371	48.7	11.43	17–83	29.2	53.8	17.0	3.6	1.86	1–15	64.9	29.60	0–100

	BEBM	BEPR	EEEN	ESAN	ESAS	FNES	FNWS	FRFE	FRVI	IEKE	ITMO	ITRE	NLDR	NLGW	NLMR
BEBM															
BEPR															
EEEN	ab	cd													
ESAN	cd	cd	bcd												
ESAS	bd	d	cd	cd											
FNES			bcd	cd	d										
FNWS			abc	cd	bd										
FRFE	bd	ad	acd	cd											
FRVI	c		abc		bcd	c	c	c							
IEKE	d	d	b	c	d	d		a	c						
ITMO	d	d	bcd	c	b	d	d	a	c						
ITRE	cd	bd	abcd	bcd	b	bd	d	b							
NLDR	c		bc	d	bcd	d	d	d		cd	cd	d			
NLGW	c	b	bc	bd	bcd	bd		bd		cd	cd	d			
NLMR			bc	cd	bd			d	c	d	d	d			

Note: Presence of letters corresponds to significant differences between breeds (<0.05). ANOVA significance (a, age of farmer;b, family size;c, workers of family);Chi-square significance (d, farmer's education level).

Table 3. Land use, by breed. Lower area, breed comparisons.

Country	Breed	*N*	Total Ha			% property Ha			% grazing			Soil productivity (%)			Terrain type (%)		
			Mean	SD	range	Mean	SD	range	Mean	SD	range	Low	Medium	High	Plain	Hill	Mountain
Belgium	BEBM	23	82.4	33.71	28–140	40.77	19.72	10–91	62.4	19.54	15–90	52.2	8.7	39.1	39.1	60.9	0.0
	BEPR	18	43.5	26.81	8–110	12.2	14.14	0–46	94.4	18.30	25–100	72.2	27.8	0.0	11.1	88.9	0.0
Estonia	EEEN	30	219.6	368.18	7–1 800	61.3	27.32	0–100	55.7	27.68	0–100	50.0	50.0	0.0	100.0	0.0	0.0
Spain	ESAN	31	760.7	633.93	84–2 740	49.1	43.10	0–100	/	/	/	70.0	20.0	10.0	13.3	70.0	16.7
	ESAS	31	188.9	277.33	8–1 300	36.8	27.88	0–93	/	/	/	56.7	36.7	6.6	19.4	41.9	38.7
Finland	FNES	30	130.7	158.71	25–882	70.9	30.40	0–100	12.9	18.12	0–84	3.4	73.3	23.3	100.0	0.0	0.0
	FNWS	31	114.8	67.02	11–283	80.9	17.91	47–100	5.0	6.72	0–21	9.7	77.4	12.9	100.0	0.0	0.0
France	FRFE	19	60.5	37.14	13–133	25.4	35.23	0–80	92.1	15.01	50–100	42.1	57.9	0.0	11.1	50.0	38.9
	FRVI	15	51.9	41.74	8–170	62.9	42.96	0–100	86.4	16.75	50–100	46.7	53.3	0.0	40.0	33.3	26.7
Ireland	IEKE	20	39.0	27.16	6–120	1.6	1.44	0.1–5	90.6	13.57	50–100	20.0	50.0	30.0	65.0	30.0	5.0
Italy	ITMO	26	67.9	78.95	11–300	30.4	45.51	0–100	3.6	10.05	0–45	46.2	19.2	34.6	34.6	19.2	46.2
	ITRE	30	64.5	74.88	7–330	28.8	54.01	0–100	0	0.0	0–0	10.0	23.3	66.7	66.7	23.3	10.0
Nederlands	NLDR	21	30.1	28.09	1–100	57.7	38.28	0–100	71.7	23.64	20–100	19.0	52.4	28.6	100.0	0.0	0.0
	NLGW	22	63.9	64.49	15–330	74.5	29.41	0–100	78.7	17.65	40–100	4.5	45.5	50.0	100.0	0.0	0.0
	NLMR	24	40.5	11.09	20–66	69.7	21.96	27–100	66.8	17.66	20–89	0.0	66.7	33.3	100.0	0.0	0.0
Total		371	151.3	15.82	1–2 740	49.6	2.12	0–100	48.0	2.29	0–100	32.8	44.2	23.0	54.5	31.2	14.3

	BEBM	BEPR	EEEN	ESAN	ESAS	FNES	FNWS	FRFE	FRVI	IEKE	ITMO	ITRE	NLDR	NLGW	NLMR
BEBM															
BEPR	bcde														
EEEN	abde	abce													
ESAN	e	ab	ade												
ESAS	de	abe	be	a											
FNES	bcde	bcd	cd	abd	bd										
FNWS	bcde	bcd	bcd	abd	bd	d									
FRFE	cde	e	ace	ad		bcde	bcde								
FRVI	cde	be	ace	ad	b	cde	cde	b							
IEKE	bcd	de	abcde	abde	abde	bce	bce	de	bcd						
ITMO	bce	cde	abcde	abe	d	bcde	bde	cd	bcd	bce					
ITRE	bcde	cde	abcde	abde	abde	bcde	bde	cde	bcd	bcd	de				
NLDR	bde	bcde	acd	ade	abde	c	bc	bcde	cde	bce	bcde	bcde			
NLGW	bcde	bcde	acd	abde	bde	c	cd	bcde	de	bce	bcde	bce	b		
NLMR	bde	bcde	acd	abde	abde	c	c	bcde	cde	bce	bcde	bcde		cd	

Note: Presence of letters corresponds to significant differences between breeds (<0.05). ANOVA significance (a, total Ha; b, % property Ha; c, % grazing;d, soil productivity: e, terrain type).

(SD 2.3), ranging from zero in ITRE to 92.1 (SD 15.0) in FRFE. Table 3 also provides the type of land on which farms are located, in terms of both soil productivity compared with the country average, and orographic structure. Across breeds, the soil occupied by farming activities is approximately equally distributed across the three categories of low (32.8 percent), medium (44.2 percent) and high productivity (23.0 percent). Low or medium soil productivity is prevalent in all but two breeds, ITRE and NLGW with respectively 66.7 and 50 percent of high-productivity soil. Only in four breeds mountain terrains are used by at least 25 percent of the herds, from 26.7 percent in FRVI to 46.2 percent in ITMO. Self-sufficiency in cattle feedstuff and organic production was also analysed (data not reported in Table 3); the percentage of self-sufficiency in production of feedstuff for the local cattle herd (Spanish data missing) on average was 91.8 percent (SD 19.7) for roughage, with little variation across breeds (82–100 percent), and 22.44 percent (SD 36.5) for concentrate, with higher variation ranging from 2 percent in ITRE to 62 percent in EEEN. The percentage of farms producing organic was on average 13.2 percent, with a consistent variation, from zero in ESAS and ITRE to 25 percent or higher in EEEN, FRVI, IEKE and NLDR. It is worth noting that at least a quarter of the farmers of the four breeds from four different countries in Eastern, Southern, Central and Northern Europe add value to the local cattle by producing organic milk or meat.

Among the 371 farmers interviewed, 145 (39.2 percent) keep on their farm only the local breed that is the object of this investigation; the remaining 226 (60.8 percent) also keep cows of one or more additional breeds. Considering all 371 herds, the average size of the local cattle herd across all breeds is 37.4 (SD 55.1) cows with some differences among breeds, ranging from 7.2 (SD 5.5) in FNES to 141.3 (SD 101.2) in EASN (Table 4). Considering both the local breed under investigation and the other cattle kept on the farm, the average cattle herd size is 61.2 (SD 82.9) cows, ranging from 10.6 (SD 5.9) in FNES to 170.3 (SD 118.9) in ESAN. Considering the 226 farms with two or more breeds, the average farmer keeps on his farm, in addition to the analysed local breed, 1.5 (SD 0.8) breeds, ranging from 1 to a maximum of 2.6 in FNES, for a total, within each local breed, of 1 (NLGW and NLMR), 4 (ITRE and NLDR), 5 (FNWS, FRVI and IEKE), 6 (BEBM, ESAN and FNES), 7 (ESAS), 8 (BEPR, FRFE and ITMO) and 10 (EEEN) additional breeds. These additional breeds include mainstream breeds such as Holstein, Brown Suisse, Limousine, Simmental, Belgian Blue Beef, Charolaise, regional and local breeds, and crosses. In the average farm keeping more than one breed, the percentage of local cows of total cows is 46.4 percent (SD 29.2), ranging from 28.3 in ITMO to 82.9 in FNWS. The presence on the farm of breeds additional to the local one can be linked to a precise strategy to increase profitability (e.g. Belgian breeds), to the country tradition of having more breeds on the farm (e.g. Finland breeds), to the cultural affection of farmers of mainstream breeds to the local breeds of their parents (e.g. Italian breeds, where some successful Holstein farmers keep a few Reggiana or Modenese cows, and French breeds), to the willingness of contributing to the conservation of the endangered breed (e.g. French breeds). In some cases, local cows are preferred for their better fertility, rusticity and maternal ability, but they are mated to mainstream breed cows to produce F1 veals (e.g. Spanish breeds).

Multifunctionality was investigated by asking the roles and functions of local cattle on the farm. Besides the obvious roles of milk to be sold or processed as cheese on the farm, meat and dual purpose, the grazing role (identified by farmers as a specific role, and not as simply a cattle activity) was recognized, across all breeds, by 11 percent of farmers, in particular 30 percent in IEKE, 33 percent in FNES and 71 percent in NLDR. Only 4 percent of farmers, across all breeds, mentioned a tourism role, 60 percent of those in the NLDR. Other roles included, e.g. in the Netherlands, nature management and energy production. Some local breed farmers are moving from traditional products to new opportunities for increasing profitability, but this approach still seems limited, for example in tourism, as we will also see from the data reported in Table 5.

Table 5 reports data on the economic role of local cattle. Farmers were asked to identify the percentage of the total family income covered by farming activities, using the following classes: from 76 to 100 percent (high), from 51 to 75 percent (medium), from 26 to 50 percent (low) and less than 26 percent (minimal). As an average across breeds, the percentage of income from the farm is high in 66.6 percent of cases, with consistent variation among breeds ranging from 20.0 percent in IEKE to 94.4 percent in BEPR. In two breeds, the income from the farm covers on average less than 25 percent of the total family income in a consistent percentage of the interviewed farmers, in IEKE (35 percent of farmers) and in NLDR (48 percent of farmers, most of them using cows just for nature management). The local cattle breed share of the total farm income is across breed 57.4 percent (SD 38.3), with a minimum of 3.3 percent in NLDR to a maximum of 87.2 percent in BEPR.

The average number of external workers, measured as the sum of full-time persons and part-time/seasonal persons multiplied by 0.25, is 0.8 (SD 4.2), ranging from 0.0 in BEBM to 1.0 in both ESAN and ITRE. Farmers were asked to partition the farm income into income from animal food products, from non-feed crop production, from forestry, from work services for other farms, from grazing as landscape management, from tourism services, and from welfare and educational services. Considering all breeds, as mentioned above, multifunctionality seems limited, with a high percentage (87.6) of the income derived from animal food products, followed by 3.4 percent from non-feed crop production and a total of 9.0 percent

Table 4. Herd size and composition, by breed. Lower area, breed comparisons.

Country	Breed	*N*	All herds Local breed			All cattle			Mixed herds % Local cattle			No. of breeds excluded the local		
			No. of cows	SD	Range	No.of cows	SD	Range	Mean	SD	Range	Mean	SD	Range
Belgium	BEBM	23	54.4	23.41	23–100	93.8	51.51	25–255	47.1	23.59	20–100	1.6	0.65	1–3
	BEPR	18	41.0	18.18	12–81	53.7	31.47	20–150	55.2	18.63	27–100	1.4	0.54	1–2
Estonia	EEEN	30	11.9	16.62	1–85	77.9	160.15	1–727	37.1	31.23	2–100	1.5	0.51	1–2
Spain	ESAN	31	141.3	101.16	31–470	170.3	118.88	31–500	68.7	26.12	29–100	1.3	0.49	1–2
	ESAS	31	52.7	82.841	2–450	76.5	90.20	7–450	41.4	24.42	10–100	1.2	0.43	1–2
Finland	FNES	30	7.2	5.49	2–25	10.6	5.93	3–25	48.5	22.58	17–100	2.6	1.25	1–5
	FNWS	31	14.6	11.52	2–50	15.4	11.34	2–50	82.9	11.41	57–100	2.5	0.99	1–4
France	FRFE	19	13.4	11.56	2–41	30.6	22.89	4–75	35.2	19.55	6–100	1.0	0.00	1–1
	FRVI	15	9.0	7.02	1–22	18.7	14.27	4–60	17.9	15.74	5–100	1.0	0.00	1–1
Ireland	IEKE	20	14.7	12.05	2–45	21.9	23.81	0–100	38.6	22.26	6–100	1.0	0.00	1–1
Italy	ITMO	26	22.0	22.16	1–80	94.0	93.79	4–452	28.3	26.81	0–100	1.2	0.41	1–2
	ITRE	30	32.7	33.40	2–170	57.1	47.52	12–170	41.3	30.86	3–100	1.1	0.32	1–2
Nedherland	NLDR	21	15.6	18.65	2–60	20.0	19.96	2–60	58.5	25.49	23–100	1.0	0.00	1–1
	NLGW	22	39.5	28.53	2–101	53.0	28.08	8–107	47.4	26.42	6–100	1.0	0.00	1–1
	NLMR	24	58.7	37.64	2–130	73.8	28.969	14–130	59.3	35.87	2–100	1.0	0.00	1–1
Total		371	37.4	55.12	1–470	61.2	82.86	0–727	46.4	29.18	0–100	1.5	0.83	1–5

	BEBM	BEPR	EEEN	ESAN	ESAS	FNES	FNWS	FRFE	FRVI	IEKE	ITMO	ITRE	NLDR	NLGW	NLMR
BEBM															
BEPR															
EEEN	a	ac													
ESAN	abc	a	abc												
ESAS			ab	abc											
FNES	abd	abd	bd	abcd	abd										
FNWS	abcd	acd	bcd	abd	abcd	ac									
FRFE	abd		bd	abc	ab	d	cd								
FRVI	abcd	ac	bd	abc	ab	cd	cd								
IEKE	abd		b	abc	ab	d	cd								
ITMO	ac	c		abc	a	bcd	bcd	b	b	b					
ITRE	d		d	abc		bd	bcd		c						
NLDR	abd		abcd	ab	ab	ad	acd	ac	c		bc				
NLGW	d		ad	abc		abd	acd	a	ac		bc				
NLMR	d		acd	ab		abd	abcd	ac	abc	ab	ac	a	ab		

Note: Presence of letters corresponds to significant differences between breeds (<0.05). ANOVA significance (a, local breed;b, no. of total cows; c, % of local cattle/total cattle; d, breeds farmed in addition to the local breed).

Table 5. Economic role and activities of the farm, by breed. Lower area, breed comparisons.

Country	Breed	*N*	Economic role of the farm Farm income/family income (%)				No. of external workers		Income shares from farm activities (%)				Income share from local cattle (%)	
			High	Medium	Low	Minimal	Mean	SD	Animals Mean	Non-feed crop Mean	Forestry Mean	Other Mean	Mean	SD
Belgium	BEBM	23	87.0	8.7	4.3	0.0	0.0	0.0	89.4	0.0	0.0	10.6	68.2	30.56
	BEPR	18	94.4	0.0	5.6	0.0	0.1	0.0	97.8	0.0	0.0	2.2	87.2	26.30
Estonia	EEEN	30	60.0	10.0	20.0	10.0	5.3	13.56	85.8	2.0	0.7	11.5	38.6	37.07
Spain	ESAN	31	58.6	13.8	17.2	10.3	1.0	2.07	95.0	0.6	0.2	4.2	79.3	28.97
	ESAS	31	37.0	18.5	33.3	11.1	0.3	1.14	91.7	7.6	0.0	0.7	70.3	35.78
Finland	FNES	30	86.3	0.0	3.3	10.0	0.2	0.40	75.8	12.4	2.4	9.4	29.1	29.44
	FNWS	31	83.9	12.9	0.0	3.2	0.1	0.18	89.5	1.0	5.7	3.8	59.6	38.66
France	FRFE	19	57.9	26.3	15.8	0.0	0.1	0.32	100.0	0.0	0.0	0.0	50.8	36.33
	FRVI	15	40.0	26.7	26.7	6.6	0.3	0.56	82.7	0.0	0.0	17.3	44.3	41.40
Ireland	IEKE	20	20.0	10.0	35.0	35.0	0.1	0.00	89.0	4.2	4.2	2.6	46.1	35.06
Italy	ITMO	26	80.8	7.7	3.8	7.7	1.0	2.96	92.	4.7	0.0	3.1	44.3	39.59
	ITRE	30	73.3	23.3	3.4	0.0	0.3	0.83	95.5	4.5	0.0	0.0	65.6	35.34
Nedherland	NLDR	21	23.8	14.3	14.3	47.6	0.5	1.63	44.7	0.7	0.2	54.3	32.3	37.71
	NLGW	22	81.8	18.2	0.0	0.0	0.8	2.57	83.7	7.8	0.0	8.6	61.0	34.44
	NLMR	24	91.6	4.2	0.0	4.2	0.1	0.00	96.4	0.3	0.0	3.3	81.5	31.58
Total		371	66.6	12.6	11.5	9.3	0.8	4.24	87.6	3.4	1.0	8.1	57.4	38.27

	BEBM	BEPR	EEEN	ESAN	ESAS	FNES	FNWS	FRFE	FRVI	IEKE	ITMO	ITRE	NLDR	NLGW	NLMR
BEBM															
BEPR															
EEEN	af	abf													
ESAN					f										
ESAS	aceg	cg	acef	cd											
FNES	acf	bcdf	acg	bcdfg	defg										
FNWS	d	dfg	adf	fg	cdg	bcdf									
FRFE	deg	fg	abe	f	c	bcdfg	d								
FRVI	fg	befg	a	be	cef	cdg	deg	e							
IEKE	df	dfg	adg	dg	cdf	bcg	g	dg	de						
ITMO	f	f	a		cfg	bcd	d		eg	dg					
ITRE	e	f	aefg		cg	bcdeg	d		beg	dg	f				
NLDR	efg	befg	abeg	beg	bcefg	bcdeg	bdefg	beg	be	bde	beg	befg			
NLGW	ac	bcf	acfg	bcf	bg	dfg	cd	bcg	ceg	dg			bcefg		
NLMR			abfg	fg	cg	bcdf	df	f	efg	dfg	f	f	fg	bcef	

Note: Presence of letters corresponds to significant differences between breeds (<0.05). ANOVA significance (a, total external workers; b, % animals farm activity; c, % non-feed crop farm activity; d, % forestry farm activity; e, % other farm activity; f, local cattle breed's share of the total farm income %:) and Chi-square significance (g, % income).

from other types of income. The percentage of income from animal food products is above 83 percent in all breeds, except for FNWS, where 12.4 percent of the income derives from non-feed crops, and NLDR, where 3.5, 12.8, 10.5 and 5.0 percent of the income derives respectively from work services for other farms, from grazing as landscape management, from tourism services and from welfare and education services. It might be worthwhile to create opportunities to exchange ideas, and to promote institutional support in order to foster multifunctionality in other breeds as a tool to increase their productivity and sustainability.

Farmers were also asked to identify the percentages of the production from either the local breed or the total herd (in the case of the presence of two or more breeds on the farm) sold as raw material on the farm, as processed material on the farm, to the local market or to the industry. For the local breed, on average most (39.9 percent) of the production is sold to industry, followed by local markets (25.4 percent), on farm as raw material (9.6 percent), and on farm as processed material (5.9 percent). Additional investigations are needed to understand the role of both industry and the local market on farmer profitability, which seems to vary from case to case. In some cases, the industry guarantees a good promotion of the breed product (e.g. Spanish breeds); in other cases the local market adds value to the product (e.g. Italian breeds). When we consider the total herd production, the percentage sold to industry increases to 44 percent and quotas sold on farm decreased by half.

Besides information on farmers and their farms, our survey aimed to understand the values and motives of farmers for keeping their local breed, their perception of the attitude of society towards them for continuing to farm local breeds instead of turning to mainstream ones, and farmers' plans on the size of their herds. Figures 1 to 7 report on these aspects.

Farmers (Figure 1) were asked to identify and rank the three main reasons for keeping their local breed from among the following: tradition (of the farm and of the farming area), multifunctionality (i.e. opportunities for multifunctional farming, including tourism, production of niche products, vegetation management), external support (presence of economic incentives or conservation programmes), functional traits, social value (including image value for the farm, link to other people who have such breeds or values, bringing pleasure to the family) and other reasons. Across all breeds, as the first reason the most frequent answer was functional traits (36 percent) strictly followed by tradition (35.4 percent), which was the most frequent answer in eight breeds (BEPR, EEEN, FNWS, FRFE, FRVI, ITMO, IEKE, NLDR). In ESAS, the most frequent first reason was external support (30 percent); in IEKE farmers indicated with equal frequency (35 percent) tradition and presence of external support. When tradition was given as the first reason, the second reason was functional traits in five breeds (BEPR, EEEN, FNWS, IEKE, ITMO), tradition again in two breeds (FRFE, FRVI), and multifunctionality or social value, with equal frequency, in one breed (NLDR). In addition,

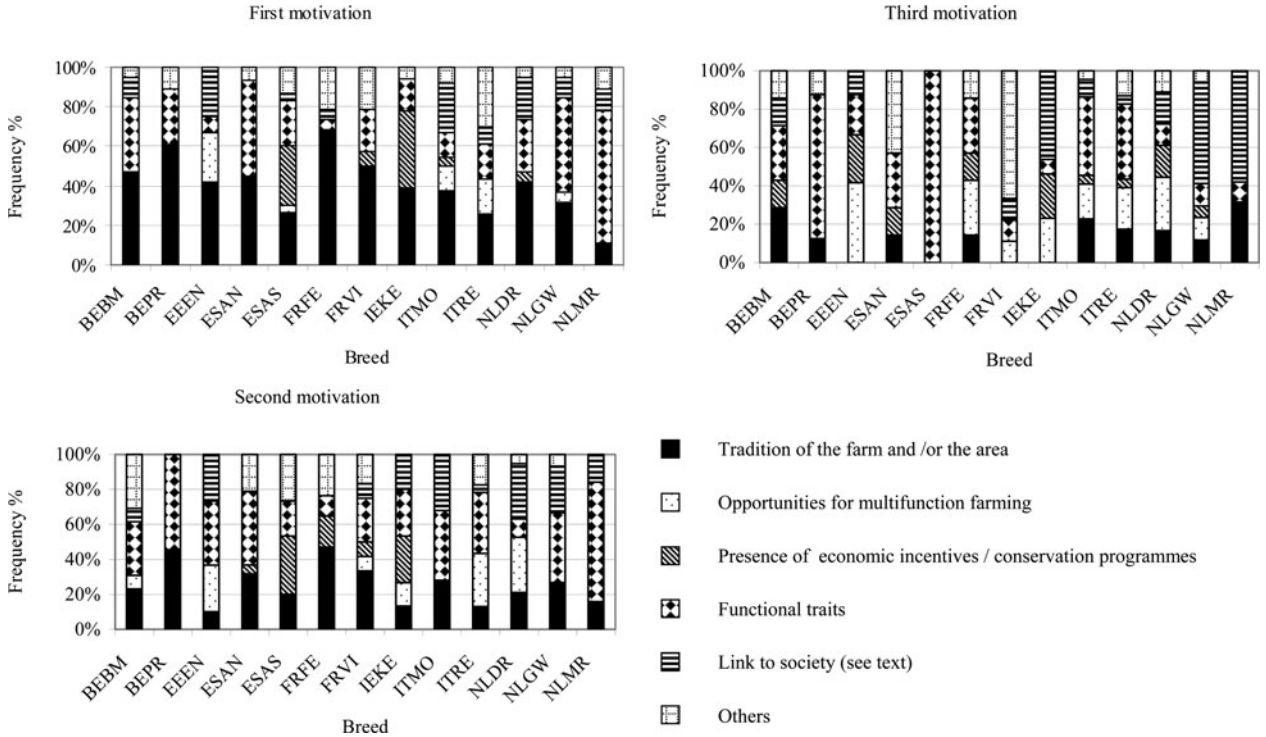

Figure 1. Three main motivations of farmers to keep the local breed.

the social reason was given as the most frequent third reason in three breeds (IEKE, NLGW, NLMR). The importance of tradition, besides productivity, suggests the importance of conservation programmes, considering the cultural aspects of local cattle farming (Gandini and Villa, 2003). The relative low importance of support from conservation programmes might reveal the average inadequacy of these to contribute to maintaining the farming of the local breed.

Farmers were asked to compare their local breed (as poor, same, good) with a mainstream breed they knew for productivity, economic profitability and functional traits (Figure 2). Farmers were asked to analyse the following functional traits, fertility, longevity, management requirement, robustness and docility, and Figure 2 reports rounded averages across the five traits. Productivity was considered poor by the majority of farmers in all breeds, as the same by about 30 percent of farmers in FNES, FNWS and NLMR. In IEKE, 20 percent of farmers valued productivity as good with respect to the mainstream breed. Comparison in terms of economic profitability increased the value of the local breed. In fact, in only six breeds the majority of farmers considered their breed as less profitable than the mainstream breed. In four breeds (BEBM, BEPR, FRFE, FRVI), productivity was considered the same by a vast majority of farmers. In three breeds (ITRE, NLGW, NLMR) more than 50 percent of farmers valued their breed as more profitable than the mainstream breed. For the Reggiana breed (ITRE) the high profitability is linked to the success of a branded Parmigiano Reggiano cheese that is sold at a high price (Gandini *et al.*, 2007). The local breed was always valued as superior or the same when comparison was on functional traits. In particular, five breeds (BEPR, FRVI, NLDR, NLGW, NLMR) were considered by 80 percent or more of the farmers as positive with respect to the mainstream. Profitability comparisons based on farmers' estimates can be misleading if production costs are not correctly considered. However, they provide some indications on the interest of farmers for their breeds and consequently on opportunities for breed survival.

The following two questions were based on the assumption that acknowledgement by society of a positive image of the farmer of local breeds can contribute to maintaining these breeds. Farmers were first asked which type of appreciation (positive, neutral, negative, do not know) they thought the following 18 categories of persons and entities have on their local breed and their products: extension persons, inseminators, veterinarians, breeding organization, farmers' associations, agricultural authorities, environmental authorities, regional authorities, food industry, research institutes, farmers of mainstream breeds, farmers without animals, non-farmer neighbours, tourists, tourism agencies, cultural societies, consumers and media. As an average over the 18 categories and the 15 breeds (Figure 3), a positive appreciation was observed in 35.2 percent of farmers, but with rather low values in the Belgian and French breeds, BEPR (5.4 percent), FRFE (11.3 percent), BEBM (11.6 percent), FRVI (13.3 percent), and a maximum in ITRE (63.9 percent). A neutral appreciation is expected on average from 32.9 percent of farmers, with a minimum in IEKE (16.5 percent) and a maximum in BEBM (73.7 percent). A negative

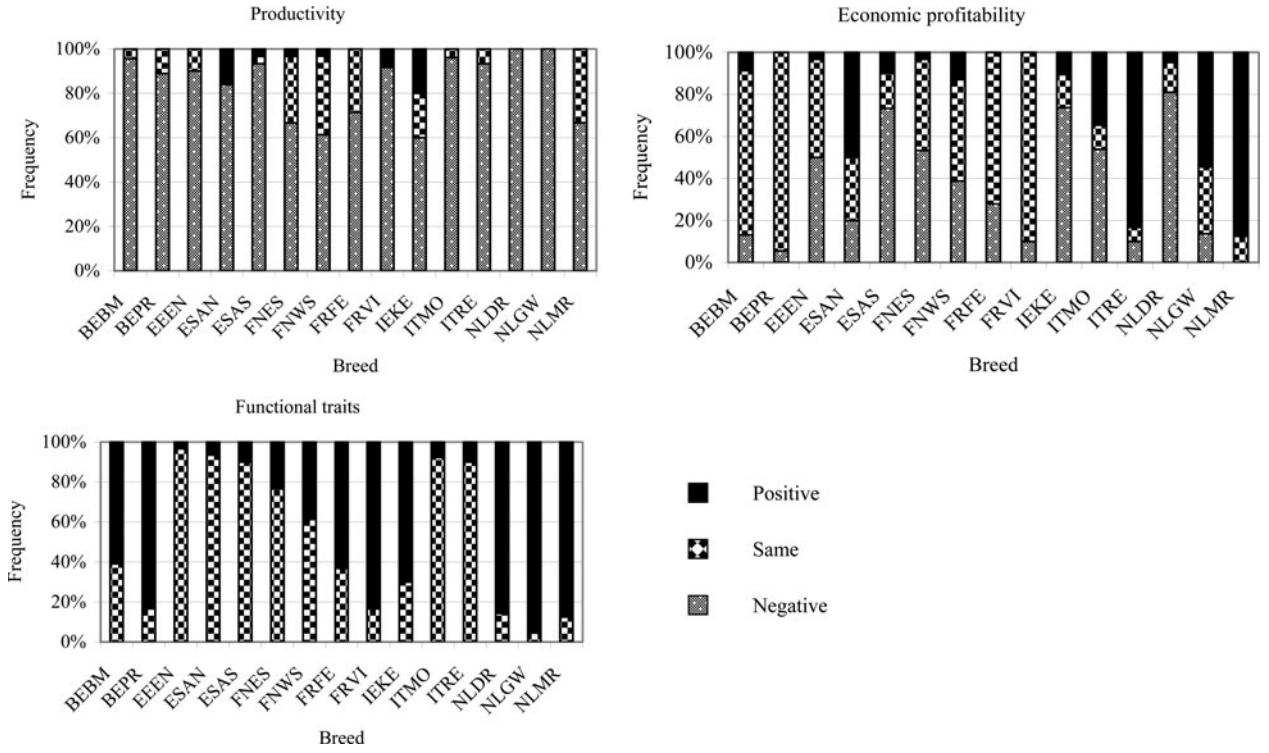

Figure 2. How farmers compare their local breed with the mainstream breed on productivity, economic profitability and functional traits.

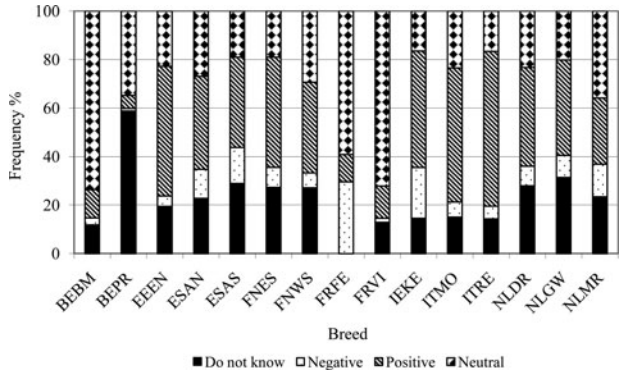

Figure 3. Farmers' view on the appreciation of their local breed and its products by 18 stakeholder categories (see text): average across the 18 stakeholder categories.

appreciation is on average expected by 9.6 percent of farmers, with two situations above 20 percent, in IEKE (20.9 percent) and FRFE (29.5 percent). A negative appreciation is expected from most farmers (37.2 percent) in the case of the category "farmers of mainstream breeds", and with a rather high percentage (19.3 percent) in the category "food industry". The percentage of farmers who did not have a precise idea (did not know) was on average 36.8 percent, ranging from zero in FRFE to 58.7 percent in BEPR. A negative appreciation was seen with a <7 percent occurrence in nine categories.

In order to further understand farmer perception of the attitude of society towards the local breed, farmers were asked to give their opinion on how (positive, neutral, negative, do not know) they think society values the following five breed attributes: quality of products, specific traits, cultural heritage, landscape conservation and source of genetic variation. As an average over all farmers, the highest positive opinion was expected for the cultural value (68.1 percent), followed by the genetic value (65.56 percent), the quality of products (63.7 percent), landscape conservation (60.5 percent) and specific traits (48.3 percent). Considering an average above the five breed attributes (Figure 4), some differences were observed among breeds, with six breeds where 75 percent or more of the farmers who think that society has an overall positive attitude towards the local breed and nine breeds where no farmers think that society has an overall negative attitude. Some variation is observed also in the percentage of farmers who did not have a precise idea (do not know), ranging from 0 percent in BEPR to 41.7 percent in ITMO and ITRE. If we assume that a positive recognition of society of the work of the farmer can enhance interest in maintaining local breed farming, it would be advisable to promote through the media the importance of local breed conservation and communication among farmers and the society as a whole.

Farmers were asked on the level of cooperation among them, in terms of participation in the activities of the breeding association, and of marketing of products and services. On average, across breeds, collaboration with the breeding association is rather high, with an average across breed of 66.9 percent and a percentage below 50 percent in only five breeds (BEBM, BEPR, FNES, FNWS, FRVI). Cooperation in marketing of products or services, on the contrary, is rather low, with an average across breeds of 23.5 percent and with only three breeds (ESAN, IEKE, ITRE) above 40 percent. The farmers of only four breeds, EEEN, FRFE, ITMO and ITRE, said that they participated in inbreeding control centralized programmes and in cooperative programmes for the development of niche products. For inbreeding control, the level of appreciation was above 85 percent in three cases except for ITMO (47 percent). Programmes on niche products were judged as failure or less appreciated, but in ITRE there was 100 percent good level of appreciation.

Farmers were asked about the size of their local cattle herd expected in five years time with respect to the current size. On average (Figure 5), 38.5 percent of farmers expect to increase the size (from 11.1 percent in BEPR to 57.1 percent in NLDR), 6.7 percent to decrease (from 0 percent in BEPR, FNES, FNWS, ITRE, NLGW to 15.8 percent in FRFE), 39.9 percent to keep the same size (from 22.6 percent in ESAS to 72.2 percent in BEPR) and 4.9 percent to give up farming (from 0 percent in seven breeds to 16.7 in

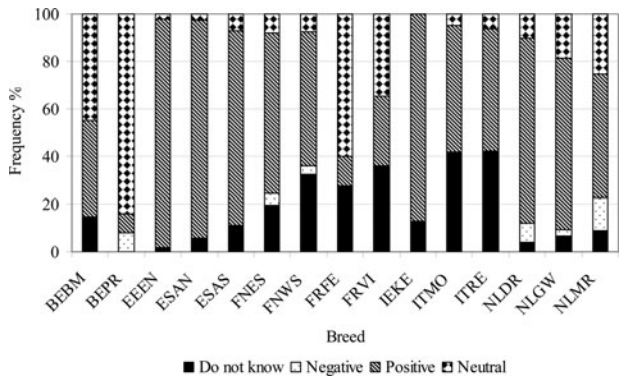

Figure 4. Farmers' view on the value attributed by society to their local breed: average over five breed attributes (see text).

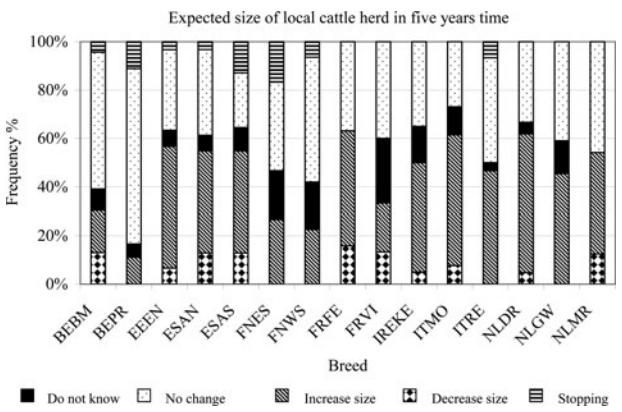

Figure 5. Changes of herd size planned by the farmer in the next five years, with respect to current size.

FNES). Ten percent of farmers said they could not predict herd size in the next five years. The high proportion of NLDR farmers expecting to increase herd size is also because many farmers started to keep this breed in the last five years and they still need to reach an appropriate herd size.

Eleven of the 15 breeds analysed benefit from economic incentives. The degree of dependence of farmers on economic incentives was estimated by asking farmers their expected behaviour (to give up farming, to decrease herd size, to keep the same herd size, to increase herd size, do not know) under three scenarios of change of subsidies: 50 percent increase, 50 percent decrease, removal. In Figure 6, for each breed, the proportions of farmers' expected behaviours are illustrated for the three scenarios. Almost all farmers seemed to know how they would react to subsidy changes, except for a high proportion of French farmers. In the case of 50 percent increase of subsidies, in four breeds (BEBM, EEEN, FNES, ITRE) most farmers will not change herd size, in ESAS and IEKE farmers will increase herd size, and in ESAN, FNWS and ITMO farmers are equally distributed among no change and increase. Under the hypothesis of removal of subsidies, in BEBM, EEEN, ITMO and ITRE most farmers will not modify herd size and in good proportion will even increase it (FNES, FNWS). Farmers of the Spanish breeds (ESAN, ESAS) and IEKE are in good proportion ready to give up farming of the local breed or to decrease herd size. The answer in the case of 50 percent decrease of subsidies is close to the case of having the subsidies removed, although slightly negative. Then, six breeds (BEBM, EEEN, FNES, FNWS, ITMO, ITRE) seem to be fairly independent of subsidies.

Signorello and Pappalardo (2003) observed that, in spite of EU support to farmers, it still remains unprofitable to rear local breeds. In seven breeds, we asked farmers how much subsidy per cow per year they would think to be reasonable to cover the lower-income profitability compared with the mainstream breeds. Responses were rather different both within and between breeds. In the Netherlands the requested incentives were on average 100 euro (SD 164.3; range 0–500) in NLMR, 172.7 euro (SD 254.3; range 0–800) in NLGW and 303.9 euro (SD 256.1; range 0–1 000) in NLDR, and in Spain they were 187 (SD 50.6; range 120–300) in ESAN and 396.1 (SD 116.5; range 200–600) in ESAS. Farmers of EEEN requested on average 370.1 euro (SD 128.8; range 256–770) and farmers of IEKE 381.3 euro (SD 183.4; range 150–1 000). Our survey detects poor homogeneity among requests, possibly different ideas among farmers on how local breed farming should be supported, and the necessity of better investigating the amount and roles of economic incentives.

Besides subsidies, we investigated which elements would support keeping the local breed on the farm. Farmers were asked to value (as positive, neutral, negative, do not know) the following six activities: increasing breed productivity, developing/promoting food products associated with the breed, promoting other – less traditional – breed roles such as vegetation management, support to social or therapy activities and cultural testimonies,

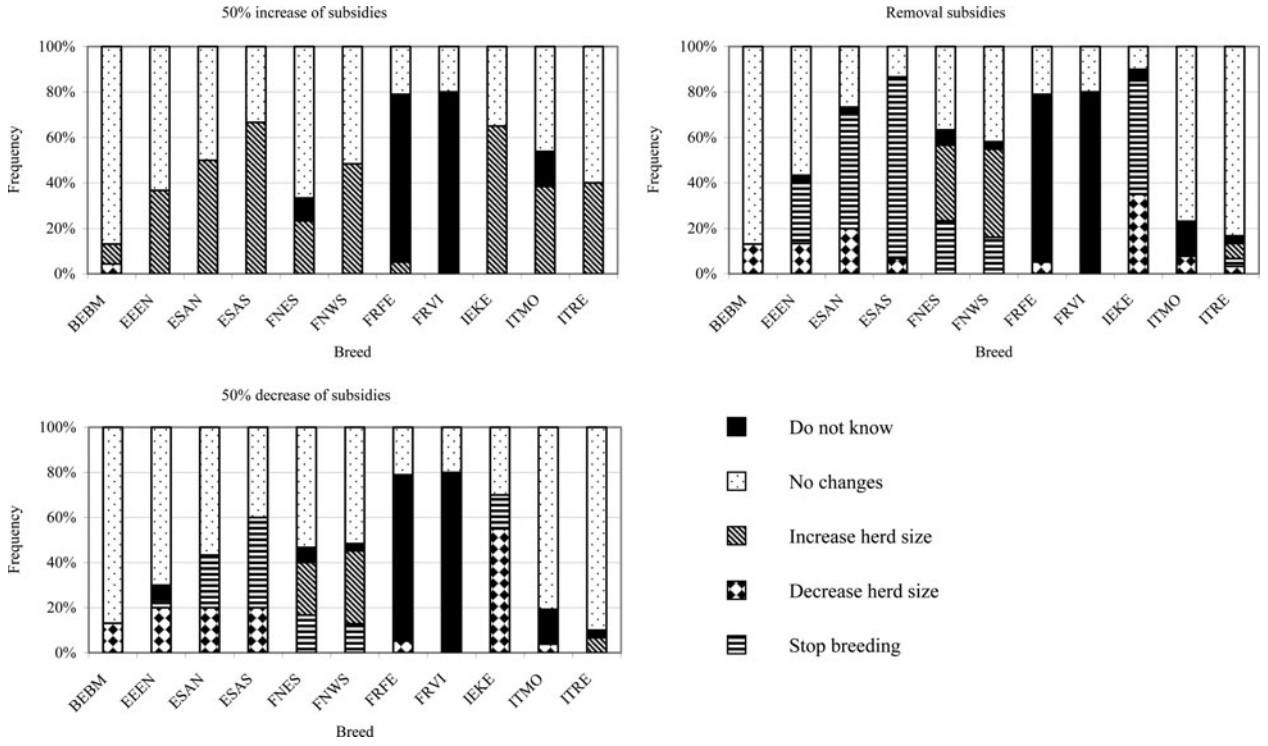

Figure 6. How farmers react to changes in the amount of subsidies. Responses in those breeds that currently benefit from subsidies.

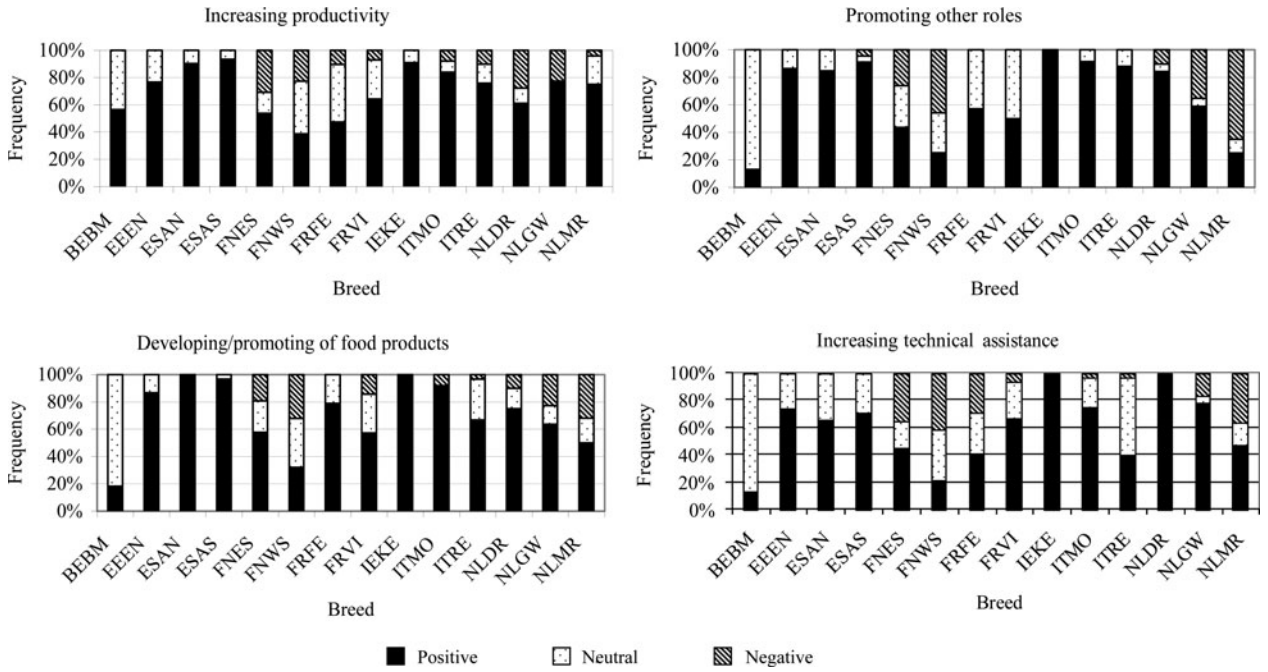

Figure 7. Opinion of the farmer on four possible activities as support to continue keeping the local breed on the farm.

increasing technical assistance, developing non-food products associated with the breed and increasing consumer awareness. The results are given in Figure 7 for the first four activities listed above. The results concerning activities improving technical assistance and increasing consumer awareness were very similar, respectively, to promoting less traditional roles and to developing/promoting food products, and are not reported in Figure 7. All activities were most often valued positively. Considering all breeds, increasing consumer awareness (not reported in Figure 7) was valued positive, with the highest average percentage (67 percent) and with seven breeds above 85 percent. High positive responses were also given on average to increasing productivity (63.5 percent) and to developing food products associated with the breed (63 percent). The highest frequency of negative responses was from Dutch and Finnish farmers. A large majority of BEBM's farmers valued all activities neutral.

Conclusions

This survey revealed a large variation between and within breeds for most of the analysed aspects. In particular, it is worth noting that almost all local breeds are kept, by a certain percentage of farmers, together with other breeds. On average, the income from local cattle covers 57 percent of the farm income. In some cases, the local breed represents a small percentage of the total cattle farm herd, and it can be questioned whether this type of farming risks having the local breeds at the edges of the production system, kept as hobby activity.

Many farmers indicated family tradition or area tradition as an important motivation to continue keeping the local breed, and it is reasonable to wonder whether this motivation will be transferred to the next generation and whether other motivations will be capable of replacing tradition.

Considering that on average local breeds are producing less milk and/or meat than mainstream breeds, besides the optimization of the low input–output production system, multifunction farming systems capable of adding value to local breeds have often been advocated. Apart from a few cases, the survey revealed that multifunctionality is still poorly adopted.

Our survey strategy was aimed not only at detecting the average situation of the 15 breeds, but also at achieving the greatest possible amount of information from each breed, and at being considered a case study (e.g. Flyvbjerg, 2006). Here we can conclude that in many breeds (e.g. ESAS, ITRE, NLDR) the traditional farmer coexists with more recent production systems, characterized by more extensive systems, greater attention to quality products or to farming for specific functions such as nature management.

Some aspects investigated provide indications on the sustainability of local cattle farming. The degree of sustainability in the short term can be directly derived by the changes in herd size expected by the farmer in the next five years. Most farmers provided this information and answers are optimistic for the survival of the 15 breeds surveyed, considering that only 13 percent of the farmers declared plans to reduce the herd size or to discontinue local cattle farming. In a larger context, other parameters such as age of the farmer, farmers' view on appreciation

from the society for the local breed, and comparison of the local cattle with the mainstream breed provided positive elements for survival of the breeds. Today most farmers receive some EU subsidies, but the survey on the 15 breeds revealed some degree of independence of farmers from public economic support.

Most farmers of the local cattle breeds demand the development of activities promoting and helping local breed farming. In particular, they favour opportunities to increase productivity and profitability through promoting non-conventional roles, and developing food products associated with the breed. However, the large variation observed among breeds suggests the need to develop conservation actions capable of being flexible and adaptable to local situations, among and within breeds. The presence of successful experiences in different countries and breeds also suggests the necessity of exchanging information about the successes and failures of conservation and promotion initiatives. Finally, we suggest that information on local cattle farming should not be restricted to the farming society, but should be extended to the whole society in order to increase general knowledge, awareness and appreciation of the work done by farmers of local cattle breeds.

Acknowledgements

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Marketing products from local livestock breeds: an analysis of eight cases

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Summary
Local breeds and minor species are hardy and able to thrive in harsh conditions. Their adaptive traits and unique characteristics (coloured wool or hides, extra-fine fibre, meat or milk with special tastes) offer opportunities for the marketing of speciality products and sustainable food production in marginal areas. This study discusses eight initiatives from Africa, Asia and Latin America that help communities to produce and market various products for niche markets: milk and dairy products from dromedaries; cashmere, wool and handicrafts from goats, sheep and Bactrian camels; and meat, meat products and handicrafts from goats and sheep. The main strategies were to seek new markets for existing or entirely new products (rather than trying to exploit existing markets). Most initiatives had some form of branding or labelling, and two had protected their products with geographical indications. Such marketing initiatives can be started with limited capital inputs but are skill and knowledge intensive. They require strong commitment to overcome seasonal fluctuations in production, the lack of infrastructure and services, and difficulties in institution building. But when well planned and carefully managed, they can help conserve breeds as well as provide a livelihood for people involved in the value chain, allowing actors earlier in the value chain – livestock keepers and small-scale processors – to capture a greater share of the value of the end product than they would by trying to serve a mass market.

Keywords: *local breeds, minor species, speciality products, niche markets, livestock diversity, value chains*

Résumé
Les races locales et les espèces mineures sont résistantes et capables de prospérer dans des conditions difficiles. Leurs caractéristiques uniques et de l'adaptation (couleur de la laine et des cuirs, fibre extrafine, viande ou lait ayant des goûts particuliers) offrent la possibilité de commercialiser des produits spéciaux et la production alimentaire durable dans les zones marginales. Ce document présente huit initiatives, mises en œuvre en Afrique, en Asie et en Amérique latine, ayant aidé les communautés à produire et à commercialiser plusieurs produits pour les marchés de niche: le lait et les produits laitiers des dromadaires; le cachemire, la laine et les produits artisanaux provenant des chèvres, des moutons et des chameaux de Bactriane; et la viande, les produits carnés et artisanaux provenant des chèvres et des moutons. Les principales stratégies utilisées visaient à chercher de nouveaux marchés pour les produits existants ou entièrement nouveaux (plutôt qu'à essayer d'exploiter les marchés existants). La plupart des initiatives ont intégré des formes de marquage ou d'étiquetage et deux d'entre elles ont protégé leurs produits avec des indications géographiques. Ces initiatives de commercialisation peuvent être lancées avec des ressources limitées en capital, mais elles demandent beaucoup de compétences et de connaissances. Elles exigent un engagement exceptionnel pour surmonter les fluctuations saisonnières de la production, le manque d'infrastructures et de services, et les difficultés dans la création d'institutions. Mais une fois qu'elles sont bien planifiées et soigneusement dirigées, elles peuvent tant contribuer à la conservation des races que pourvoir les moyens d'existence à ceux qui s'occupent des chaînes de valeur, permettant ainsi aux premiers acteurs de la chaîne – sélectionneurs et petits transformateurs – d'être plus en mesure d'obtenir une part plus importante de la valeur du produit final qu'en essayant de desservir un marché de masse.

Mots-clés: *Races locales, espèces mineures, products de spécialité, marchés de niche, diversité de bétail, chaînes de valeur*

Resumen
Las razas locales y las especies menores son resistentes y capaces de producir bajo duras condiciones. Sus rasgos adaptativos y características únicas (lana o piel pigmentada, fibra extrafina, carne o leche con sabor especial) ofrecen la oportunidad de comercializar productos especializados y para la producción sostenible de alimento en zonas marginales. Este trabajo trata de ocho iniciativas llevadas a cabo en África, Asia y América Latina, que ayudan a las comunidades a producir y comercializar varios productos para nichos de mercado: leche y productos lácteos de dromedarios, cachemir, lana y artesanías de cabras, ovejas y camellos Bactrian, y carne, productos cárnicos y artesanías de cabras y ovejas. Las principales estrategias consistió en buscar nuevos mercados tanto para productos existentes como nuevos (más que intentar seguir explotando los mercados ya existentes). La mayor parte de las iniciativas se basaron en la creación de marcas o etiquetas, y dos en la protección de sus productos con indicaciones geográficas. Tales iniciativas de marketing se pueden poner en marcha sin necesidad de desembolsar una importante cantidad de capital pero requieren de unas grandes habilidades y conocimiento. Precisan de una fuerte dedicación para superar las fluctuaciones estacionales de la producción, la falta de infraestructura y servicios, y las dificultades en la creación de organismos. Sin embargo, cuando están debidamente planificadas y gestionadas, pueden ayudar a conservar razas, así como a proporcionar el medio de vida de aquellas personas que forman parte de

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la cadena de valor, permitiendo a los actores que trabajan en las primeras fases del proceso de la cadena de valor – propietarios del ganado y transformadores a pequeña escala – poder obtener un margen de beneficios mayor del producto final, que lo que obtendrían tratando de atender al mercado masivo.

Palabras clave: *razas locales, especies menores, productos especializados, nichos de Mercado, diversidad del Ganado, cadenas de valor*

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Introduction

Research and breed improvement programmes in the past century concentrated on the "big five" – cattle, sheep, goats, pigs and chickens – and breeding for production. Locally adapted breeds of these species and other, "minor", species such as camels, donkeys and yaks were regarded as unproductive and uneconomic, and received little attention. This negative view is changing slowly amid a recognition that in many countries locally adapted livestock contribute substantially to food production and security, provide many non-food services, are valuable gene reservoirs and preserve option values – traits that may currently be of no commercial interest but may be of large value in the future if environmental and economic conditions change (FAO, 2007, 2009; Rodriguez, 2008).

But rural development efforts continue to promote large-scale cross-breeding and breed replacement – often with little knowledge or appreciation of the local breeds they are driving out. Such efforts are now reaching remote areas, and so are likely to speed up breed extinction. This makes it urgent to find ways of stimulating the sustainable use of local breeds and minor species.

A small but growing number of initiatives have started to explore the special characteristics of locally adapted livestock for economic development. A recent book "*Adding value to livestock diversity*" (LPP *et al.*, 2010) describes and analyses eight such cases – three each from Asia and Africa, and two from Latin America – where people in marginal areas produce and market speciality products from local breeds and minor species (Bactrian camels, dromedaries, goats and sheep). The raw products include wool, cashmere, meat, hides and milk.

This paper summarizes the findings of this book, drawing heavily on the analysis chapter. It describes the cases and the marketing strategies used, and discusses their impacts and sustainability.

The definitions of "breed" and "local breed" in this paper follow the Food and Agriculture Organization of the United Nations (FAO) (2007, pp. 25 and 339).

The cases

Eight cases

The cases represent a range of production systems, from sedentary (the South Africa case), through transhumant (the cases on Kyrgyzstan and goats in Argentina), to nomadic pastoralist (Somalia, Mongolia and Mauritania). In all cases, the animals are kept under extensive management and with few external inputs. The following sections provide short summaries of the cases. The full text of the cases can be downloaded from: www.fao.org/docrep/012/i1283e/i1283e00.htm

Wool and cashmere

- *Deccani sheep wool, India* (by Gopi *et al.*): An NGO has organized shepherds and processors in the Deccan plateau to produce high-value handicrafts from a seemingly

Photo 1. India: The various colours of wool from Deccani sheep. Photo: Ilse Köhler-Rollefson.

Photo 2. Mongolia: Wool from Bactrian camels in southern Mongolia has found a new market in the United States. Photo: Ilse Köhler-Rollefson.

unpromising product – coarse, brown wool from the Deccani sheep, an endangered breed. The project combines community organizing with product design and entrepreneurial marketing (Photo 1).

- *Jaidari (local) goat cashmere, Kyrgyzstan* (by Kerven and Toigoinbaev): The project helps goat raisers in remote mountain areas produce higher-value cashmere by introducing a cheap, simple technology (combs, which cost a mere $7 each). It also links them with buyers in Europe and Japan.
- *Bactrian camel wool, Mongolia* (by Schmidt *et al.*): Camel wool has many properties that make it attractive to hobby knitters in the United States. A development project and NGO are developing a value chain to link women in southern Mongolia who spin yarn from camel wool with American knitting enthusiasts (Photo 2).
- *Linca sheep wool, Argentina* (by Cardinaletti *et al.*): Women in the Andes foothills of Patagonia weave coloured wool from this local breed and make ponchos and other traditional items. They sell them to tourists through a community-run sales outlet.

Meat and hides

- *Umzimvubu goat meat and hides, South Africa* (by Roets *et al.*): A government-led initiative generates income for farmers in a disadvantaged part of the country through a major investment in infrastructure (an abattoir, tannery and restaurant), research, training, extension activities and institutional development, as well as developing new products (leather handicrafts, meat cuts and sausages) and market linkages (Photo 3).

Photo 3. South Africa: Umzimvubu goats have created a leatherworking industry in the Eastern Cape, based on skins from local goats. Photo: Merida Roets.

- *Criollo goat meat, Argentina* (by Lopez Raggi *et al.*): A university-led project helps producers in Neuquén to obtain a protected designation of origin seal for an existing product (goat meat) to differentiate it in the market and enable producers and processors to charge higher prices (Photo 4).

Milk

- *Dromedary camel milk, Mauritania* (by Abeiderrahmane and Abeiderrahmane): The Tiviski dairy is a commercial venture that has defied expert advice to collect milk from mobile pastoralists hundreds of kilometres away, produce quality products and sell them in a crowded market in competition with imports. Camel milk is a niche product in Mauritania because it caters to a particular segment of the market (people from the north of the country). The Tiviski dairy has also attempted to export a truly speciality product – camel cheese – to Europe, but has encountered bureaucratic barriers that must still be surmounted (Photo 5).
- *Dromedary camel milk, Somalia* (by Nori): Informal networks of local women have established a functioning marketing system that brings untreated, uncooled milk from remote, mobile herders to the growing city of Boosaso – amid the restrictions of the clan system in Somalia and the lack of a central government (Photo 6).

Situation before the niche marketing initiative

In all eight cases, the livestock keepers used to raise their animals mainly or partly for subsistence: They or their families and neighbours consumed much of the meat and milk produced, and they wove the wool into various handicrafts and garments for home use. Most also produced an unprocessed, low-value product (unsorted, unwashed fleeces; hides; live animals and milk) for sale. These

Photo 4. Argentina: Goat producers in Neuquén hope to boost the market for their animals through a protected designation of origin. Photo: Maria Rosa Lanari.

Photo 5. Mauritania: The Tiviski dairy in Nouakchott has established a marketing chain for dromedary milk. Photo: Omar Abeiderrahmane.

items competed with similar, often superior, products from other breeds (white Merino wool) or locations (cashmere from China, imported milk from Europe). None of the livestock-keeping groups had tried to exploit the specific characteristics of their breeds commercially. For this and other reasons, many of the breeds were in decline.

Many of the animals were multipurpose: they also produced various other products and services – milk, tillage, dung and transport. In several cases, the animals in question were not the main source of income or livelihood for the livestock keepers. The Linca sheep breeders in Argentina, for example, also keep larger flocks of Merino sheep; Somali herders keep cattle and other species besides their camels; and farmers in South Africa grow crops and raise other livestock apart from goats.

Photo 6. Somalia: The marketing of camel milk in Puntland is managed by a network of women traders. Photo: Michele Nori.

Motivation for intervention

Poverty alleviation and economic development were the main motivation for six of the eight cases, while establishing a profitable business was behind the other two (Mauritania and Somalia). Additional motivations were breed conservation (four of the cases, all relating to wool and cashmere), nature conservation (camels in Mongolia) and preserving a lifestyle (sheep in India).

Champions

Seven of the eight cases involved a "champion" – a dedicated individual, group or organization from outside the community of livestock producers, but with intimate knowledge of the local area, who decided to change the situation. Only in Somalia did the marketing effort go back to a local initiative: stimulated by the growing demand for milk from the rapidly growing cities, local women started to market camel milk. Here an external project came in later, helping to improve an existing value chain.

Type of interventions

The projects focused on four different types of interventions.

Animal production

Several of the projects attempted to increase or improve production of the animals that produce the raw materials by establishing breeding herds, increasing the number of animals with the desired traits and improving animal management and health. However, in none of the cases was production of the raw material a major focus of the project.

None of the projects focused on modifying animal production to achieve specific production standards (such as organic production) or other production-related goals (e.g. environmental and breed conservation, or enhanced animal welfare standards). But such goals were indirectly included in the Argentinean goat project, the Mongolian camel case and the South African goats initiative.

Processing

Improving the processing of the raw materials was a major focus in most of the cases. This meant establishing factories (in Mauritania and South Africa), designing new products (in India), introducing new techniques (in Mongolia and India), and improving sorting and grading (in Kyrgyzstan).

Organizing

Organizing groups of producers and processors was key in several cases. This might mean organizing them in production cooperatives, employing them as staff, establishing formal companies or subcontracting work out to processors. Organizing efforts are not always successful, however, as shown by the attempts to form groups of producers or processors in Kyrgyzstan, Mongolia and Mauritania (see the section on Institutions).

Building a value chain

All the cases included efforts to identify markets and build a value chain, linking producers with processors and markets.

Target markets

All cases except for Somalia produce speciality products (see below), targeting environment-conscious consumers, tourists, fashion houses, hobbyists and barbecue party hosts in urban centres. Three of the seven projects export their products (sheep wool in India, cashmere in Kyrgyzstan and camel wool in Mongolia). None focuses primarily on local rural consumers.

In the Somali case, traders sell camel milk to urban residents. It serves more of a mass market, as in Somalia much milk comes from dromedaries.

Marketing strategies

Table 1 provides an overview of the main marketing strategies of the cases. Most of the cases tried to market already existing products, either through labelling an existing product and selling it in an existing market (called "market penetration" according to Ansoff, 1957) or through developing new markets ("market development"). None of the cases started with the development of new products for existing markets ("product development"), although some did so at later stages. Three diversified their product spectrum by developing new products for new markets ("diversification").

Table 1. Marketing strategies of the eight cases classified according to Ansoff (1957).

Market	Product	
	Existing	New
Existing	**Market penetration** • Argentina: goat meat	**Product development**
New	**Market development** • Kyrgyzstan: goat cashmere • Mongolia: Bactrian camel wool • Argentina: sheep wool • Somalia: dromedary milk	**Diversification** • India: sheep wool • South Africa: goat meat and handicrafts • Mauritania: dromedary milk

Increasing risk

Risk increases from the upper left corner to the lower right corner. The three cases with the highest risk are incidentally all projects with substantial investments either in product design (India) or in processing technologies and infrastructure (South Africa and Mauritania).

The reasons for diversification included a falling demand for established products and the need to find new ways to market raw products. In India, the demand for coarse, coloured wool from Deccani sheep was declining in the markets that shepherds traditionally supplied. The solution was to develop new products (specially designed shoulder-bags) for new markets (foreign buyers). In South Africa, the local demand for goats was sporadic, and so farmers had little interest in raising more animals. Existing customers would not be interested in other products from the goats, and so it was necessary to find new markets. In order to supply these markets with items they would buy, it was necessary to create new products (meat, sausages and handicrafts) and establish a processing facility to produce these materials.

In Mauritania, camel herders had a surplus of milk that they could not sell (because of lack of a buyer) or would not sell (because of cultural barriers). The Tiviski dairy's innovation was to identify a potential market for this product in the capital city, and to create the facilities needed to bring the milk there, process it and deliver it to customers.

Once these enterprises had developed their new products and established themselves in the new markets, they were free to pursue lower-cost, less risky strategies to expand their sales. They have adopted both product- and market-development strategies. Both the Indian and South African enterprises are continually expanding their range of bags, rugs and handicrafts, and are seeking new buyers and retail outlets. The dairy in Mauritania has also expanded its range of dairy products into various types of yoghurt and cheese made from the milk of cows and goats as well as camels, and has invested in a heat-treatment plant for milk. It sells dairy products to cities other than the capital, as well as to neighbouring countries.

The four Ps of marketing

This section analyses the cases in terms of the "four Ps" of marketing (product, price, place and promotion), highlighting fundamental issues that marketing initiatives need to address.

Products

All but the Somalia case produced speciality products. The Indian, South African and Argentinean sheep cases centred on attractive handicraft designs, while goat raisers in Kyrgyzstan produced unusually fine cashmere. Mongolian camel wool is hypoallergenic, while meat

from the South African and Argentinean goats has a distinctive taste. The Mauritanian dairy products are of high quality and have a long shelf-life.

In all instances, the characteristics of the breed or species are vital features of speciality products. In Kyrgyzstan, the goats' fine cashmere, which evolved to cope with harsh winters, is the most valuable part of the fleece. The coloured wool of the Indian Deccani and Argentinean Linca sheep enables artisans to make handicrafts with distinctive designs. Softness and attractive natural colours are major features of Mongolian camel yarn. The multicoloured hides of the South African goats allow the firm to make a range of attractive leather handicrafts. And the taste of the local goat meat – a result of the combination of breed and environment – is one of the bases of marketing goat meat in Argentina.

Price

None of the enterprises sell their products at prices lower than the competition. Some have deliberately positioned themselves at the upper end of the market. The goat meat in Argentina, for example, is designed to appeal to people willing to pay a little more for an extra-tasty barbecued rib. The Tiviski dairy's strategy in Mauritania emphasizes superior quality and good packaging. And the South African enterprise processes much of its meat into sausages, which can be sold at a higher mark-up than regular cuts of meat.

Although they do not compete on price, they are all affected by market forces and must compete at some level with similar products. India has many self-help groups that make handicrafts, limiting the price that the enterprise can charge for its bags and rugs. The price for fine cashmere is set by the world market, and Kyrgyzstan's poor reputation in cashmere production and lack of market organization surely limit the number of buyers and the prices they are willing to pay. Mongolia's camel wool must compete with other speciality wools used by American hobbyists. And if one Somali milk trader or Argentine poncho maker charged more than the rest, they would quickly find that their product would fail to sell.

Place

In marketing theory, "place" refers to the location where a product is sold – a stall, shop, supermarket or website. The following cases illustrate a number of locations where the products can be sold.

Own sales outlets

The point of sale is especially important for the wool products in Argentina: a cooperative-run retail outlet in the small town of Dina Huapi and a retail store in Buenos Aires are the only places where it is possible to buy the ponchos and other handicrafts made by the cooperative members. This means that sales staff (local women who make the items for sale) can meet customers and tell them about how the products were made. Running its own sales outlets also allows an enterprise to capture a larger percentage of its products' value, because it is not necessary to give a wholesale discount to third-party retailers. But as the cooperative grows, this may prove too restricting, and it may have to seek new outlets for its products.

Third-party retailers

Three cases rely almost entirely on third-party retailers: The goat meat in Argentina is sold via supermarkets, butchers and restaurants, while the Mauritanian dairy products are distributed through 2 000 retail outlets. The camel milk in Somalia is sold by a network of market retailers in the city.

Mixed outlets

The enterprise in South Africa uses a mixture of sales outlets: It has its own retail outlets (a restaurant and handicraft store) on site but sells much of its produce through third-party outlets: the meat goes to nearby butchers and other small, local retailers, while the leather items are sold through craft retailers throughout the country. The Indian wool-product enterprise also has a mix of outlets: It exports much of its output, sells much of the rest through third-party retailers in India and has started marketing through its website.

Exports

Three cases focus on export markets. In India, the cooperative that manages production recognized that it lacks skills in marketing, and so created a partly owned subsidiary to handle this aspect. Since then, its sales have boomed. In Kyrgyzstan, village organizations sell cashmere to foreign buyers. The Mongolian camel wool is sold through volunteers and an international distributor, and can be bought in hobby shops in the United States. These two cases describe relatively new ventures, and they have not yet managed to establish stable marketing chains.

Promotion

Promotion refers to how the product is promoted and advertised. The following cases illustrate various approaches to promotion.

Emphasizing product features

The features of a speciality product make obvious selling points. Enterprises in each of the cases draw customers' attention to the natural colours of wool, the fineness of cashmere, the superior taste of meat or the quality of the milk. Even in Somalia, where a raw product is sold,

fresh milk sells for a higher price than a product that has gone sour in the heat.

Branding and labelling

The majority of cases describe this. Mongolian camel wool is sold under a special label initiative in the United States; goat meat and leather handicrafts are sold in South Africa under the "Umzimvubu goats" label, while in Mauritania, the Tiviski dairy sells its products in attractive packaging under its own brand. It is not necessary to insist on a brand, however: In India, the wool enterprise does not brand its products but instead relies on the design of its product range to carry its product identity.

Emphasizing local links

Basing the product on a distinctive local tradition ties it in the customers' minds to that area. That can be important, for example, for products aimed at tourists. An example of this approach is the ponchos and other handicrafts made from Linca sheep wool in Argentina. The cooperative emphasizes local links in various ways: the product itself (distinctive garments – ponchos – woven in ethnic designs), the label showing who made the item (creating an unseen link between the maker and the buyer) and through the sales staff.

Geographical indications

"Geographical indications" are a special type of labelling that make local links explicit and allow producers to label their products in an exclusive way. Two of the cases describe protected designations of origin, a specific type of geographical indication: the "Northern Neuquén Criollo kid" designation in Argentina and the "Gobi desert camel wool" designation in Mongolia. As the Argentina case shows, the process for establishing a geographical indication is far from simple, and once it is established, a great deal of effort has to be put into marketing the product and ensuring that producers comply with the requirements. Geographical indications are relatively new to livestock marketing in the developing world but offer much potential for marketing indigenous breeds.

Project inputs

Research

Research was a key ingredient in seven cases (there is insufficient information about the Somalia project). This research included three types:

- *Production research* studying the production process and the social and economic situation of the producers. This was often done through a combination of formal studies and informal, participatory research that involved producers.
- *Product research* focusing on the product itself: characteristics of the wool or cashmere fibre, breed genetics, milk characteristics and product development. This research required the services of specialized institutions, in some cases located abroad.
- *Market research* investigating the potential market for the product, quality requirements, etc. It was typically done by marketing organizations and consultants.

It is hard to overstate the importance of adequate research when planning interventions such as these cases. But even the most detailed research does not guarantee success: other factors, such as political changes (the European Union's ban on milk imports from Mauritania), macroeconomic trends (the long-term decline in demand for coarse wool) and unexpected events (the loss of a key staff member, the arrival of a competitor), may ruin an otherwise well-thought-out plan. Good research will anticipate many such hazards, but it cannot predict them all.

Technology

Adding value usually means introducing new technologies. The cheapest inputs in terms of technology were probably in Kyrgyzstan, where the project introduced low-cost combs for the goat herders to buy. The interventions in India, Argentina (sheep) and Mongolia also involved low-cost equipment to card and spin wool.

The cases in South Africa and Mauritania involved large-scale investments in factories, processing equipment and transport. These bigger ventures can potentially benefit larger numbers of people and have a bigger impact on the local economy. But they may also be riskier if the venture has to be handed over to local management (as in South Africa), if the investments do not meet the need of the producers or if markets change.

The latter risks are illustrated by the case from Somalia, where low-cost, community-based interventions (providing milk containers and building basic market facilities) were more successful than the effort to establish a large-scale processing plant, probably because the former strengthened the local value chain rather than trying to modify it according to outsiders' ideas. The example from Somalia also shows that value chains can develop without any chain-specific outside investment.

Training

Training and extension were a key element in many of the cases. At least four types of training were provided:

- increasing or improving production, such as how to collect milk in a way that meets basic hygiene standards;
- processing to add value to products, such as building skills in spinning, weaving, sorting and grading;
- organization, such as group formation, leadership and cooperative management;

- enterprise development, including business and marketing skills.

Some of the training was formal: Goat producers in South Africa received 10 months of training and a formal qualification on animal production. Other courses were shorter, such as those given to the Kyrgyz and Mongol spinners. Some of the training was on-the-job, for example the experience gained by women who took turns to sell handicrafts in the cooperative in Argentina.

Transport and communication

Transport and communication were key elements in most of the cases.

Arranging transport from the producer to the processing centre or point of sale was vital for live animals or meat and milk, both of which are highly perishable. The South African and Indian enterprises and the Somali milk traders arranged to collect the raw product from the livestock keepers, either using their own vehicles or by third parties. Wool and cashmere are not perishable, and so transport from producer to processor was less critical in these cases.

The problem of obtaining the processed products to the retailer or consumer also had to be addressed in several of the cases. Solutions included using their own or third-party transport or arranging shipments via export companies. At least two cases solved the problem by having buyers come to them: The cooperative in Argentina caters to passing tourists, while in Kyrgyzstan, village organizations rely on visits by traders to buy their cashmere.

Long distances make good communication vital. Much of this communication occurs via established linkages, networks and cooperatives. Where such institutions exist and can be adapted for the new value chain, it is important to build on them rather than to try to create new linkages.

Two of the cases (sheep in India and camels in Mauritania) mention the increasing importance of mobile phones. Signal coverage is still sparse in many areas, especially in remote and mountainous areas, but mobile phones are becoming a vital link between raw material producers and the enterprise they supply. The Internet is important further down the chain. E-mail and websites link the enterprise with customers throughout the world: They enable enterprises to promote products, identify potential customers, negotiate deals, coordinate deliveries and maintain trust.

Standards

All the cases involved some kind of standards for product quality. In some cases, this was imposed by outsiders. Cashmere, for example, is traded according to recognized standards on the world market.

In other cases, the enterprises themselves imposed strict standards. In India, the enterprise sets design criteria to guide the artisans who make the handicrafts and instituted controls to ensure that they comply. The Tiviski dairy in Mauritania also emphasizes quality: It tests all incoming milk, ensures that its products are produced hygienically and takes back unsold produce from retailers to ensure that customers do not purchase out-of-date inventory.

Even in the absence of standards, indirect mechanisms such as demand and prices may foster quality: Members of the Argentina sheep wool cooperative get paid only when the products they have made are sold. In the case in Somalia, milk that has gone sour because of the heat and bumpy roads fetches a lower price than fresh milk.

Institutions

Building some form of institution featured in all eight cases, but the types of institutions varied widely: a loose, spontaneous network (Somalia), production and marketing groups (Mongolia, Kyrgyzstan), coordination bodies (Argentina goats), large, formal cooperatives (Argentina sheep, India, South Africa), and a private company (Mauritania).

Most of these institutions had specialized functions and were active only at the beginning of the chain (the shepherds' cooperatives in India), in the middle (the network of women milk traders in Somalia) or at the end (the organization that distributes Mongolian camel wool in the United States).

Several of the larger institutions had multiple functions and covered most or all of the chain: the Tiviski dairy in Mauritania, the enterprise in South Africa and the cooperative in Argentina. They not only performed functions within the chain (processing, transport, quality control, etc.), but were also responsible for managing the chain as a whole. Still, certain tasks may be left to specialists or groups having the necessary skills. The Tiviski dairy in Mauritania deliberately has not got into the business of producing milk – it leaves this to camel owners who are specialized in this task. The Indian enterprise has handed responsibility for marketing to a specialized company.

Six of the institutions had evolved from development projects that involve government, donors, NGOs, consultancy companies and research institutes. In three of the cases, the institution building has been successful. In India and Argentina, cooperatives manage the production and marketing of wool products. Good product design, active marketing and buoyant demand result in profitable enterprises and rising incomes for members, and attract new members to join the cooperative. A democratic structure and clear rules encourage members' involvement in the cooperative's work. In South Africa, a community-controlled company manages the production and marketing of goat meat

and handicrafts, but governance problems need to be fixed if it is to function properly.

In three other cases, attempts at institution building are still at an early stage, or initial attempts have failed. In Kyrgyzstan and the Argentinean goats case, it is too early to tell whether attempts to institutionalize the marketing have been successful. In Mongolia, the NGO leading the project has tried to create producers' cooperatives to manage the production and marketing of camel wool. But cultural and logistical constraints make it difficult for artisans in widely scattered locations, some of whom are nomadic, to get organized. The NGO is thus left with the task of coordinating production and marketing itself.

The Mongolian case illustrates a dilemma that is typical of market-development projects: Should efforts go first into building local institutions and then to helping them produce products and build links to the market? This approach runs the risk of local people losing interest because they do not see a quick return. Or should the project seek first to match a product to a market, then build the local institutions and transfer responsibility to them? This approach risks failure because it proves impossible to transfer the skills and responsibility adequately.

The Mauritanian case is different because no transfer of skills and responsibilities was involved. Tiviski is a private dairy company that established and manages the marketing chain, and is committed to make it work. The case also illustrates how hard it is to build local-level institutions. The dairy encourages its suppliers to form interest groups or cooperatives. Paradoxical though it may seem, this would be in Tiviski's interest: Strong local groups of suppliers would be negotiating partners on subjects such as prices and quality, and would ease activities such as organizing, payments, quality control and extension work. But efforts to organize such groups have failed, for similar reasons to those in Mongolia: the independent, mobile lifestyle of the pastoralists.

In the eighth case, Somalia, the milk marketing system was established by local women without outside involvement. Like the Tiviski dairy, they have a built-in commitment to making the chain function. Outsiders have tried to improve the marketing system by building infrastructure and providing equipment. This had met with only limited success, however: A dairy established by outsiders operates only part-time because it is poorly integrated with the local system.

External influences

Influences lying beyond the control of marketing efforts include culture and government policy.

Culture

The livestock keepers' culture had an impact on the activities described in the cases. For example, in Mauritania a taboo initially hindered the sale of camel milk. But this was eroded by the marketing effort and broader social changes. Other restricting cultural factors include the division of labour and caste, and, in the case of pastoralists, mobility. This mobility makes it difficult to organize various types of production and marketing activities.

But the relationship between culture and marketing is not just one way. Marketing efforts link communities to the outside world, and so inevitably induce cultural changes (see the Impacts section).

Policy

In four of the eight cases, government policy was broadly supportive of the enterprise (Mongolia, Argentina sheep and goats, and South Africa), for example, through research and export certification, supportive policies, and granting land and funds.

In India, inconsistent policy on value addition and the withdrawal of government contracts undermined the wool industry in the Deccan. On the positive side, the government has given grants to support the handicraft industry.

In three cases, government has had very little involvement in the enterprise. The Tiviski dairy in Mauritania complains of the lack of government support, while in Kyrgyzstan and Somalia there has been no government contribution to the marketing efforts. In Somalia, the lack of government interference has probably sustained rather than hindered the development of the chain. However, the value chains in Kyrgyzstan and Somalia probably need active government support if they are to develop further, for example by making it easier for the women to obtain credit.

International regulations can act as a severe impediment to the development of value chains. The clearest example of this is the Mauritanian dairy, which has tried to export an innovative product (camel milk cheese) to Europe, only to run up against a ban on imports of dairy products from Mauritania.

Market developments

Rising demand for speciality products allows livestock keepers to charge higher prices for their products. But if the demand exceeds the supply of the local breed, the enterprise (or its rivals) may decide to reduce the amount of the local breed in the product. Wool or cashmere can be blended with more plentiful fibres; camel milk can be mixed with cow's milk; sausages can be made with a mixture of meats. Pressure may arise for other breeds or a larger area to be admitted to a protected designation of origin. Enterprises may cheat, passing off one product for another. None of these have yet occurred in any of the cases, but they do happen elsewhere.

Rising demand may also trigger producers to raise more and more animals, resulting in overgrazing (see the Impacts section). Companies may start sell similar items to the same market, out-competing the original producer group or driving down prices – a common phenomenon wherever a product gets popular.

Impacts

The marketing efforts have at least six potential impacts: on the beneficiaries, pro-poor effects, local breeds, the culture of the beneficiaries, the environment and gender.

Beneficiaries

The largest enterprises (Mauritania and South Africa) have the largest number of beneficiaries (over 3 000 families each, counting producers and employees). The amount of information on the other cases is limited, but it seems that numbers vary from about 50 (Mongolia) to 1 500 (Argentina goats).

Livestock keepers

In all cases, the livestock keepers benefited through higher, more stable prices, increased demand for their products, a more reliable market, or some combination of these items. These outcomes were reached by enhancing the quality or the amount of raw material or creating a market for it.

Only in three cases were the livestock keepers themselves responsible for adding value to the product. In Kyrgyzstan, women goat keepers comb the fine cashmere from their animals' coats before shearing the fleece. In Argentina, it is the women sheep raisers who make the ponchos and handicrafts sold in the store. And in Mongolia, women pastoralists spin the camel wool that is shipped to the United States.

In the Argentinean goat case, the value is added through labelling – in which the livestock keepers have no direct input – but at least some of the higher price accrues to them.

The livestock keepers also benefit in another, more intangible way. By becoming part of a value chain that increases their incomes without damaging the environment, they can gather government support. This is important in areas where governments tend to view livestock keepers, especially itinerant ones, as a problem or threat, and try to get them to change their lifestyles, settle in permanent locations and start growing crops.

Processors

In four other cases, the livestock keepers benefit only indirectly through higher demand or a more reliable market. The value addition is done by others: artisan members of self-help groups in India, employees of the Tiviski dairy in Mauritania and the enterprise in South Africa, and women traders in Somalia.

Reasons for this include the technology, skills and scale needed to, for example, transport over long distances, make sausages, supply packaged items to supermarkets, cool and pasteurize milk, comply with supermarkets' hygiene requirements and produce large amounts of uniform products.

Service and input providers

In all the cases, people other than livestock keepers and processors also benefit. They include transport companies, retailers, and suppliers of inputs and services at each stage in the value chain.

Pro-poor effects

As described above, marketing of products from local breeds has increased (or promises to increase) the incomes of various groups. It may have the fortuitous effect of being pro-poor by default because it is often the poor who keep local breeds (LID, 1999) and the type of work or amount of income generated may make it unattractive for wealthier individuals. In Mongolia, for example, the larger-scale herders did not get involved in spinning wool: They were too busy managing their herds and maybe did not need the small amount of additional income generated through spinning. Much of the spinning was therefore done by women in poorer households and rural centres.

In addition to such inherent pro-poor effects, several of the cases consciously attempted to help the poor by scaling up through creating self-help groups (India), providing a market for small-scale farmers (South Africa) and paying the same price per litre of milk regardless of how much milk the animal's owner delivers (Mauritania).

Such choices can be commercially painful. Dealing with a large number of small-scale producers is costly and presents challenges in quality control. The enterprise in South Africa is under pressure to buy animals from commercial farmers outside the district and so it can guarantee the supplies it needs. And the Tiviski dairy in Mauritania knows that dealing with small amounts of milk from many suppliers is expensive.

But seemingly positive pro-poor effects may also have their downsides (although the cases do not mention these). For example, animal owners may be tempted to sell as much milk as possible, leaving less for the (hired) herders, their own families or the calves. That may result in a paradox: a higher cash income but impoverished labourers, malnourished children and higher calf mortality.

Breeds

The wool and cashmere cases generally report a positive stimulus on the breeds and species in question. Increased demand or higher prices encourage livestock keepers to keep more of the animals (as in the India and Argentina sheep cases), and prevent cross-breeding and establish

elite breeding herds (as in Kyrgyzstan). A successful value chain can also convince governments that it is worth protecting and investing in a breed and in the things needed to support it – such as ensuring access to public grazing land and providing veterinary care.

At least two of the cases (Mauritania and South Africa) experience problems in obtaining sufficient supplies of the raw product (camel milk and live goats), despite offering a reliable market and guaranteed prices. It appears that other factors – climate, availability of grazing, political factors and culture – influence the availability of the product, and perhaps the fate of these breeds. And without strong links between the product and the breed, enterprises may be tempted to use raw materials from other breeds or species, or from cross-breeds, to increase output (as in Kyrgyzstan).

Many animals produce more than one type of product, and these products may compete with one another. If a livestock raiser discovers that it is more profitable to sell live animals or meat rather than milk or wool, the breed itself may be endangered – as was the case in Mongolia before the start of the camel wool project.

Culture

Marketing efforts can both undermine and reinforce local culture. For example empowering women, trivializing traditional products in order to please tourists, opening contacts with a consumer society or encouraging mobile herders to settle in one place potentially can weaken the local culture. The outcome of such changes finally depends on how society handles them. If empowering women leads to increased divorce rates as reported in the Mauritanian case, the women will be better off only if the traditional or national law does not outcast or disadvantage divorced women.

In other instances, the marketing efforts can reinforce the local culture, for example, by increasing the awareness and pride of local people and outsiders in their cultural values (including the local breeds), empowering local people to press for their interests, encouraging them to rediscover lost skills or reviving traditional handicrafts.

Environment

Two of the cases included environmental conservation as specific goals: The Mongolian camel project began as an environmental conservation initiative and was implemented by a conservation NGO. The Criollo goats initiative in Argentina includes environment in the criteria for its protected designation of origin certification. In both these cases, impacts on the environment of the marketing activities are indirect rather than explicit.

Linking livestock keepers to a value chain may have adverse effects on the environment. This may occur if the owners begin to keep more animals than the environment can sustain. In India, shepherds are increasing the size of their flocks, and so the enterprise is trying to persuade them to grow fodder crops rather than overgrazing the pasture. Adverse effects may also occur if the mobility of pastoralists is constrained. In Mauritania, pastoralists have a choice: They can either stay in the vicinity of the milk collection points or take their animals in search of better grazing but risk losing income from milk sales. Their choices are reflected in the dairy's seasonal purchases of camel milk.

In Somalia, a more flexible system has emerged, where the milk collectors – themselves community members – follow the herds during the migrations. This enables and encourages mobility. Even here, though, some herders have begun to keep their lactating camels near their huts where they can milk them easily, while sending non-lactating animals further afield.

Broader trends may mask or accentuate the environmental effects of a marketing project. In most countries, rapid urbanization, population growth, changing lifestyles, the conversion of land to other uses, the decline of mobile pastoralism and climate change are much larger influences on the environment than the creation of a value chain for a particular product. In Mauritania, for example, it is unclear whether the tendency for pastoralists to settle in one location is because of the dairy's milk purchases or part of a broader trend towards settlement and urbanization. While the causes for such changes lie outside its control, a marketing initiative can reinforce them, accept them as a fact of life or try to counteract them.

Women

Marketing of products from local breeds and minor species offers benefits for women, especially if the products are fibre or milk based. Women are directly involved in all the cases in various activities: production, processing and marketing.

Women and men often play complementary roles in livestock raising: Men typically manage the larger animals (cattle, camels), shear the wool and sell high-priced assets such as livestock. Women typically are responsible for smaller animals (sheep, goats) and calves, handle activities such as spinning and weaving, and sell low-priced products such as milk and wool. This division of labour is most clearly shown in the Somalia case.

This distinction opens the possibility for value chains to empower women and benefit them economically. Women in our cases earned income, learned skills, and gained power and respect in their societies. They also invested significant amounts of time and effort in work that can be tedious (spinning), physically demanding (hauling heavy milk cans) or hazardous (travelling long distances). They are forced to balance this work against other demands on their time, such as childcare, household

work and managing livestock. Their other commitments may limit their incomes from the marketing activities. More women might benefit if equipment could be introduced to reduce drudgery – although introducing machinery sometimes means a shift in tasks and benefits to men.

Development efforts aimed at women frequently find that men become interested when they see that an activity can earn money. They take over, leaving the women behind.

Sustainability

How sustainable are these marketing initiatives? Four cases appear to be sustainable. In India, the wool enterprise has a profitable business model, a growing pool of suppliers and long-term relationships with its buyers. The poncho makers in Argentina appear to be serving a niche, although it is unclear how large its potential market is and whether it can grow significantly. In Mauritania, the Tiviski dairy is the market leader; it has a long history of creating innovative products and successfully competes with lower-priced rivals. The discovery that camel milk has therapeutic qualities is opening up a promising niche market of diabetic or health-conscious consumers. In Somalia, the women traders supply a rapidly growing urban market with a vital product.

That does not mean that these initiatives are secure. Foreigners' tastes for Indian handicrafts may change, a recession in Argentina may mean fewer tourists with less money to spend on ponchos, subsidized imports from the European Union may ruin the Mauritanian dairy's sales, civil war may disrupt the Somali milk traders or a reinvigorated government may introduce taxes or hygiene and veterinary controls. But these are risks similar to those faced by many businesses, and not just in the livestock sector or in the developing world.

The future of the other four enterprises is more doubtful. The Kyrgyzstan goats initiative shows promise: It is based on an existing resource and is not capital intensive. However, it depends on transferring knowledge and skills, establishing a reliable value chain and building strong local institutions. It is also sensitive to the world price for cashmere and the activities of Chinese traders in country. Government support is needed to ensure that this chain can become better established.

In Mongolia, the camel wool initiative must make the difficult jump from a project-sponsored activity to a self-sustaining business venture. It is necessary to nurture local institutions that can coordinate the wool production and marketing. Without this, the enthusiasm of the donors and volunteers will eventually wane, and local people will be unable to take on their roles.

In South Africa, the goats enterprise must overcome governance problems and ensure a reliable supply of live animals so that it can expand its operations. This will probably mean putting more emphasis on its commercial operations rather than its social responsibilities. This is a large project, and so it is in the interests of the government, its main sponsor, to ensure that its money has been invested wisely.

The Criollo goats initiative in Argentina is too new to judge whether it will be a success. As the first application under the law that governs the country's protected designations of origin, it is charting new territory. Much will depend on whether consumers can be persuaded to pay extra for a speciality product, whether the board that manages the designation of origin functions as hoped and whether livestock keepers can benefit financially from the labelling. An additional risk is competition: If Argentina's many other meat producers see it as a successful marketing effort, they are likely to imitate it, driving down prices and eliminating any financial benefits for the Criollo goat keepers.

Recommendations

What elements are needed for a marketing initiative based on local breeds and minor species to be successful and sustainable? Here are some suggestions:

- *Use existing resources*. The initiative should be based on existing resources: the livestock breed, natural resources, traditional knowledge and human resources, and use the environment in a sustainable way.
- *Identify a suitable entry point*. To conserve a breed or benefit livestock keepers, it may be better to focus on some aspect of the chain other than working directly with livestock keepers. For example, developing an urban-based processing industry to increase demand for the raw materials may be the best way to benefit livestock keepers (or conserve the breed).
- *Start small*. The initiative should invest first in human capital and at a small scale, rather than in costly infrastructure. If the activity works, it should then seek more capital investment.
- *Do the research*. It should be based on a thorough understanding of the production system, the product and the market. That means studying the breed and its characteristics, the livestock keepers and their production system, the range of potential products and the potential customers for the products.
- *Identify special characteristics of the breed*. The initiative should seek ways to market products that reflect these characteristics: by creating new products, refining existing traditional products or finding new markets for existing products.
- *Find a viable business model*. The initiative should generate income for all actors in the value chain.
- *Focus on quality*. It should emphasize the need to maintain quality. A speciality product can command higher prices only if it is superior to alternative products.

- *Build capacity*. It should stimulate the creation of strong local institutions and train people in technical and management skills.
- *Do not depend too much on outsiders*. The initiative may require significant support from outsiders over the medium term but should not depend on expertise or funding from outsiders over the long term.
- *Ensure long-term demand*. The product chosen should be one where demand is likely to grow over the long term.
- *Do not put all your eggs in one basket*. The initiative should be based on a range of products and markets: That way, it is not a disaster if one product fails to sell or one customer refuses to buy.

Conclusions

Local breeds have special characteristics providing the basis for the production and marketing of unique products. This offers one of the few opportunities to increase employment and incomes in remote, marginal areas and can improve the livelihoods of livestock keepers and people involved in the processing and trade of products. It may especially benefit women and the poor because it is normally the poorer livestock keepers who maintain the breeds or who have the skills to process the products.

Efforts to promote marketing from local breeds and minor species may help local people connect to markets for the first time, giving them skills that they can use in exploring other markets and developing other enterprises. They may allow actors earlier in the value chain – livestock keepers and small-scale processors – to capture a greater share of the value of the end product than in a mass market. This will make it attractive for these actors to continue and expand their businesses.

When setting up an initiative to market speciality products from local breeds, key challenges to overcome include the following:

- The products of local breeds may currently have low quality or be available only in small quantities or during certain seasons.
- Local conditions are often demanding, with distance, drought, disease, and a lack of infrastructure and services all making production and marketing difficult to manage.
- Organizing producers and processors may be difficult, especially among mobile pastoralists.
- Livestock keepers may lack the capacity to manage a market-oriented business.
- Government policies and institutions may be unsupportive.
- It can be difficult to identify a suitable market for products and to establish reliable links with customers, especially in export markets.

Impacts on breeds, environment and culture can be both positive and negative and may require strategies to manage potential problems and mitigate negative outcomes.

Marketing speciality products is by nature relatively small scale. For large numbers of producers, it cannot replace the need to produce products for a wider, mass market. But for local breeds, it may be possible to find a match between the qualities of the breed, the features of a particular product and the demands of a specific market. Making this match will help conserve the breed as well as provide a livelihood for people involved in the value chain.

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Current arrangements for national and regional conservation of animal genetic resources

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Summary
Many countries have implemented cryoconservation to help better manage their animal genetic resources (AnGR). Multicountry gene banks may have a role in an international effort for the management of AnGR. To better assess such activities, the Intergovernmental Technical Working Group on AnGR of the Commission on Genetic Resources for Food and Agriculture invited the Food and Agriculture Organization of the United Nations (FAO) to report on the status of national and international programmes for storage of AnGR. FAO thus implemented a survey on this topic in January 2010. The questionnaire comprised 16 questions on various matters related to AnGR conservation, including multinational gene banks. Valid responses were received from 166 persons from 90 countries. Many countries practise AnGR conservation, with *in situ* programmes being the most common. The number of cryoconservation programmes is about half the number of *in situ* programmes for most livestock species. Fully operational gene banks were reported in about 20 percent of the countries, and plans for a gene bank within 5 years were indicated in an additional 50 percent of the countries. Lack of financial support and low priority in national livestock policy were the most commonly cited obstacles for gene banking. Very few multinational gene banks were reported, but interest in such activities was high. Aversion to multicountry gene banks was noted in only about 10 percent of countries. Among the factors contributing to the paucity of multicountry AnGR gene banks are a lack of funding, regulations on international exchange of genetic material and a lack of consensus on procedures for the operation of gene banks.

Keywords: *animal genetics resources, conservation, national, regional, questionnaire*

Résumé
De nombreux pays ont appliqué la cryoconservation pour mieux gérer leurs ressources zoogénétiques. Les banques de gènes multinationales pourraient jouer un rôle important dans le cadre d'un effort international pour la gestion des ressources zoogénétiques. Afin de mieux évaluer ce genre d'activités, le Groupe de travail technique intergouvernemental sur les ressources zoogénétiques de la Commission des ressources génétiques pour l'alimentation et l'agriculture a invité la FAO à présenter un rapport sur l'état des programmes nationaux et internationaux pour la conservation des ressources zoogénétiques. La FAO a ainsi conduit une enquête sur ce thème au mois de janvier 2010. Le questionnaire comprenait 16 questions sur des thématiques différentes associées à la conservation des ressources zoogénétiques, y compris les banques de gènes multinationales. On a reçu des réponses valables de 166 personnes provenant de 90 pays. De nombreux pays pratiquent la conservation des ressources zoogénétiques et les programmes de conservation *in situ* sont les plus courants. Le nombre des programmes de cryoconservation est environ la moitié du nombre des programmes de conservation *in situ* pour la plupart des espèces d'animaux d'élevage. On a signalé la présence de banques de gènes complètement opérationnelles dans environ 20 pour cent des pays et de plans pour la mise en place de banques de gènes d'ici cinq ans dans 50 pour cent supplémentaires des pays. Le manque de soutien financier et l'attribution d'une priorité faible dans les politiques nationales en matière d'élevage ont été les obstacles mentionnés le plus souvent dans la mise en place des banques de gènes. Les banques de gènes multinationales signalées ont été très rares, mais l'intérêt dans ce genre d'activités est très élevé. L'aversion pour les banques de gènes multinationales a été observée uniquement dans environ 10 pour cent des pays. Parmi les facteurs qui contribuent à la pénurie des banques de gènes multinationales pour les ressources zoogénétiques, on signale le manque de financements, les règlements sur l'échange international de matériel génétique et le manque de consensus sur les procédures à utiliser pour le fonctionnement des banques de gènes.

Mots-clés: *Ressources zoogénétiques, conservation, national, régional, questionnaire*

Resumen
Muchos países han implementado la crioconservación para ayudar a que se gestionen mejor sus recursos zoogenéticos (AnGR por sus siglas en inglés). Un banco de germoplasma compuesto de varios países puede desempeñar un papel relevante en el esfuerzo ejercido a nivel internacional para la gestión de los AnGR. Para valorar mejor estas actividades, el Grupo de Trabajo Técnico Intergubernamental de la Comisión de Recursos Genéticos para la Alimentación y la Agricultura, invitó a la FAO a que informara acerca de la situación de los programas nacionales e internacionales para el almacenamiento de AnGR. Por consiguiente, la FAO puso en marcha una encuesta

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sobre este tema en enero de 2010. El cuestionario estaba compuesto por 16 preguntas sobre varias materias relacionadas con la conservación de los AnGR, incluyendo los bancos de germoplasma compuestos de varios países. Se recibieron respuestas válidas de 166 personas desde 90 países. Muchos países llevan a cabo la conservación de AnGR, siendo los programas de conservación in situ los más comunes. El número de programas de crioconservación es aproximadamente la mitad del número de programas de conservación in situ para la mayoría de las especies de ganado. Se informó que en el 20% de los países, aproximadamente, existen bancos de germoplasma totalmente operativos, y existen planes para la puesta en marcha de bancos de germoplasma a lo largo de los próximos cinco años en un 50% adicional de los países. La falta de apoyo financiero y la baja prioridad dentro de las políticas nacionales relativas al ganado fueron los obstáculos más comúnmente mencionados para la creación de los bancos de germoplasma. Se tuvo conocimiento acerca de un reducido número de bancos de germoplasma compuestos de varios países; sin embargo, el interés en dichas actividades fue alto. Sólo alrededor del 10% de los países señaló tener aversión por los bancos de germoplasma compuestos de varios países. Entre los factores que contribuyen a la falta de bancos de germoplasma compuestos de varios países se encuentran la falta de financiación, reglamentación sobre el intercambio internacional de material genético y la falta de consenso acerca del funcionamiento de los bancos de germoplasma.

Palabras clave: *Recursos Zoogenéticos, conservación, nacional, regional, cuestionario*

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Introduction

In the early part of the current decade, member countries of the Food and Agriculture Organization of the United Nations (FAO) undertook a wide-scale effort to evaluate and report on the status of animal genetic resources (AnGR) within their respective countries. The information contained in the individual country reports was analysed and synthesized to yield the State of the World's Animal Genetic Resources for Food and Agriculture (SoW-AnGR – FAO, 2007b). The SoW-AnGR confirmed that the world is losing genetic diversity of AnGR at an alarming rate, and many breeds are at risk of extinction.

In an initial step to address this problem, the member countries negotiated and adopted the Global Plan of Action for Animal Genetic Resources (GPA, FAO, 2007a). The GPA is a rolling plan that outlines actions to be taken nationally and internationally to improve the management of the world's AnGR. The GPA comprises 23 Strategic Priorities, each assigned to one of four Strategic Priority Areas. One of these Strategic Priority Areas is the conservation of AnGR. Strategic Priority 10 of the GPA is to "Develop and implement regional and global long-term conservation strategies" (FAO, 2007a). Action 3 of this strategic priority is to "establish regional and global networks of gene banks for animal genetic resources and harmonize approaches to conservation in gene banks and to facilitating exchange".

The first steps in undertaking this Strategic Priority Action and monitoring its implementation are to establish a baseline of current activities and to take note of any existing policies or regulations that may impact its achievement. Therefore, at its Fifth Session, the Intergovernmental Technical Working Group on AnGR of the Commission on Genetic Resources for Food and Agriculture "invited FAO to prepare a document on the current arrangements for existing regional storage systems, including existing health and other relevant regulations for the exchange of genetic materials among countries" (FAO, 2009). To that end, the FAO implemented over the Internet a voluntary survey of persons involved in the management of AnGR within their respective FAO member countries. The survey covered various topics regarding AnGR, with a primary focus on the operation of national and international gene banks for the conservation of AnGR. The objective of this study was to evaluate and interpret the results of this survey.

Materials and methods

Questionnaire

A questionnaire was developed consisting of 16 questions. The complete questionnaire is in Appendix 1. The questions were of several different types, addressing various topics. The first four questions requested personal information, including country and role in the management of national AnGR. Questions 5 and 6 addressed the respondents' perception on importance and awareness of AnGR-related activities within their respective countries. Questions 7–10 dealt with ongoing and planned national activities in AnGR conservation, including gene banks. Questions 11–15 addressed various aspects of participation in multicountry gene banking activities, whereas Question 16 simply offered the respondents the opportunity to make general comments.

Because standard animal breeding terminology was used in the various questions, and AnGR professionals were targeted in the survey, for brevity, no specific definitions or clarification of phrases and terms such as "straightbreeding of local breeds" versus "well-managed use of exotic breeds" (Question 5) or "*in situ*" versus "*ex situ–in vivo*" conservation (Question 7) were given. Therefore, interpretation of the questionnaire assumed that all respondents interpreted these terms in the same way as each other and in the same way as the authors. The use of alternative

definitions of such terms by respondents could have thus introduced a source of variability in the responses that was not accounted for in the analysis and interpretation of data.

The questions were of various structures, including multiple choice with single or multiple responses, assignment of ratings according to ordered categories, and indication of yes or no for multiple inquiries within tables. For several of the multiple-choice questions, "Other" was available as a potential response and users were asked to define "Other" if that response was chosen. Some questions regarded personal information and opinions, whereas others regarded national issues.

The questionnaire was made available over the Internet at SurveyMonkey.com (Portland, OR, USA) during the period from 15 to 25 January 2010. A general invitation to respond to the survey was sent to all users of the DAD-Net LIST server on AnGR operated by FAO. More than 1 000 persons are subscribed to DAD-Net. In addition, all FAO national coordinators (NCs) for AnGR were sent an invitation, although most, if not all, are DAD-Net members by default. Response to the survey was entirely voluntary and no password protection or other approach was used to restrict access to the questionnaire. No limit was placed on the number of respondents per country.

Data analysis

Some of the survey questions were on individual and personal aspects, whereas others regarded national issues. For those questions on national issues, only a single response was used per country, even for countries for which more than one response was received. Therefore, various procedures were used to obtain consensus response from the multiple responses from the same country.

For Questions 5 and 6, for which respondents provided numerical ratings regarding national importance and awareness, respectively, of AnGR-related activities, the data were evaluated by obtaining the means across countries. Therefore, when there were multiple respondents per country, a consensus response was obtained by calculating the mean of responses.

Questions 7 and 8 addressed the operation of AnGR conservation programmes within each country. For these questions, the consensus response was obtained by combining the individual responses. In other words, if a single person claimed that a given conservation programme existed (Question 7) or that a certain organization was operating a conservation programme (Question 8), then this information was assumed to be true, even if no other person cited the existence of these activities.

In general, Questions 9–13 and Question 15 primarily addressed national policies and plans regarding national and multinational gene banking of AnGR. For these questions, different approaches were taken depending on whether or not one of the respondents was the NC of a given country. If the NC responded, his or her response was taken as the final response, under the assumption that the NC would be fully informed on the country's policies and plans for the future. If none of the multiple responses were from the NC, then the consensus was the combination of response that (1) favoured the existence of a given AnGR-related entity, or (2) was "most favourable" for the national or multinational gene banking of AnGR. Question 10 is an example of the first of these cases; if any respondent indicated the existence of a certain obstacle to national gene banking of AnGR, then that obstacle was included in the consensus response. For Question 12, the second approach was applied; if anyone from a given country indicated willingness of the country to participate in multicountry gene banking, then that willingness was assumed to be genuine.

Statistical tests were applied in some instances to test for significant differences among responses, and the tests applied were exact tests, chi-square or analyses of variance, depending on the question.

Results

Completed questionnaires were obtained from 166 persons from 90 countries. Table 1 lists the countries by their respective region, according to FAO definitions. Europe was the region from which the most countries were represented. Denmark, Ethiopia and India were the countries

Table 1. Countries with persons that responded to the questionnaire.

Region	*N*	Countries
Africa	23	Benin, Burkina Faso, Burundi, Côte d'Ivoire, Cameroon, Chad, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Madagascar, Mozambique, Niger, Nigeria, Rwanda, Senegal, South Africa, Swaziland, United Republic of Tanzania, Togo, Uganda, Zambia and Zimbabwe
Asia and Pacific	15	Australia, Bangladesh, China, Fiji, India, Mongolia, Myanmar, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand and Viet Nam
Europe	29	Albania, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Moldova, Republic of, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Turkey and the United Kingdom
Latin America	10	Argentina, Plurinational State of Bolivia, Brazil, Costa Rica, Dominican Republic, Guatemala, Mexico, Peru, Suriname and Uruguay
Near East	11	Algeria, Egypt, Iraq, Jordan, Mauritania, Morocco, Oman, Sudan, Tunisia, Uzbekistan and Yemen
North America	2	Canada and the United States of America

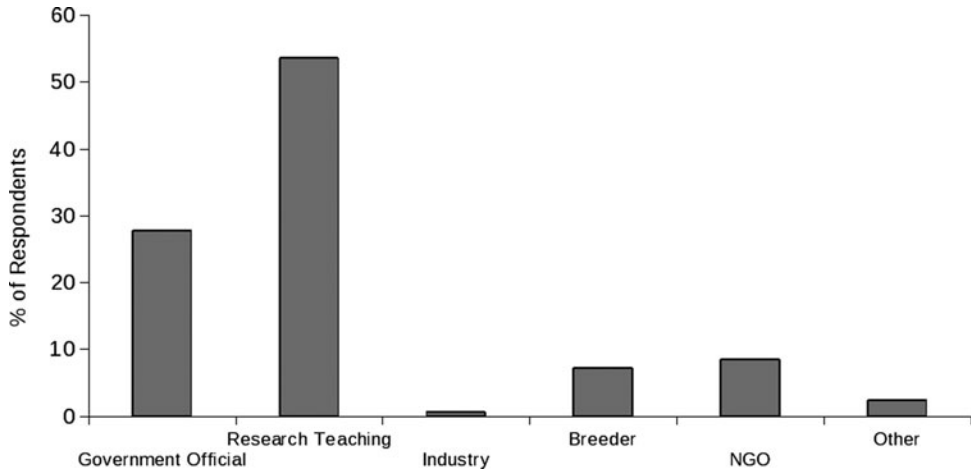

Figure 1. Distribution of the roles of the respondents in the management of AnGR within their respective countries.

from which the most responses were obtained (six each). Fifty of the respondents were NCs at the time of the survey. Several additional respondents identified themselves as NCs in the questionnaire.

Although standard animal breeding terminology was used in the various questions, no specific definitions of terms such as "straightbreeding" or "genetic improvement through well-managed use of exotic breeds" were provided.

Figure 1 has the distribution of persons according to their role in AnGR management within their respective countries. The majority (54 percent) of the persons responding were involved in teaching and research. This proportion was nearly twice as great as the next group, government officials, which comprised 28 percent of the total.

Table 2 summarizes the perceptions of the respondents regarding the level of understanding by local stakeholders about the importance of AnGR. Researchers were considered to understand AnGR issues in nearly half of the countries (44 percent) and a lack of understanding was noted in only 2 percent of the countries. These results are not surprising, given the large proportion of researchers and teachers among the respondents, and may be biased. In fact, 66 percent of researchers and teachers believed that researchers in their countries understood the importance of AnGR; this proportion was about 50 percent among non-researchers. Individuals from countries with multiple responses generally rated the knowledge of researchers higher than individuals from countries with a single response, which explains why the individual proportions (50 and 66 percent) are greater than the national proportions (44 percent). Policy-makers and farmers and breeders were considered to have a similar level of knowledge and the general public was considered to be the most poorly informed stakeholder group. In no country was the importance of AnGR considered to be well understood by the general public.

Figure 2 shows the relative importance of various AnGR activities in the countries from which responses were obtained (see Appendix 1, Question 5). The mean national rating was obtained by assigning responses to an ordered numerical scale with "Not important" = 1 and "Very important" = 4. Highly significant ($p < 0.001$) differences in the importance of various activities were observed.

Conservation of local breeds was considered the most important activity, whereas reconstitution of local breeds from a cryobank was the least important. Genetic improvement through straightbreeding of local breeds was considered more important than through the use of exotic breeds ($p < 0.01$). No significant difference was reported between the importance of genetic and phenotypic characterization ($p = 0.64$).

Additional analyses were undertaken across and within regions (no figure shown). The most variability across countries was for the importance of genetic improvement through crossbreeding and reconstitution of breeds from cryobanks. With respect to differences between regions,

Table 2. Proportions (percent) of countries for which different stakeholder groups were perceived to have various levels of understanding about the importance of animal genetics resources (AnGR).

Level of understanding	Policy-makers (%)	Researchers (%)	Farmers and breeders (%)	General public (%)
Good	9	44	3	0
Partial	61	53	64	32
Poor	30	2	32	68

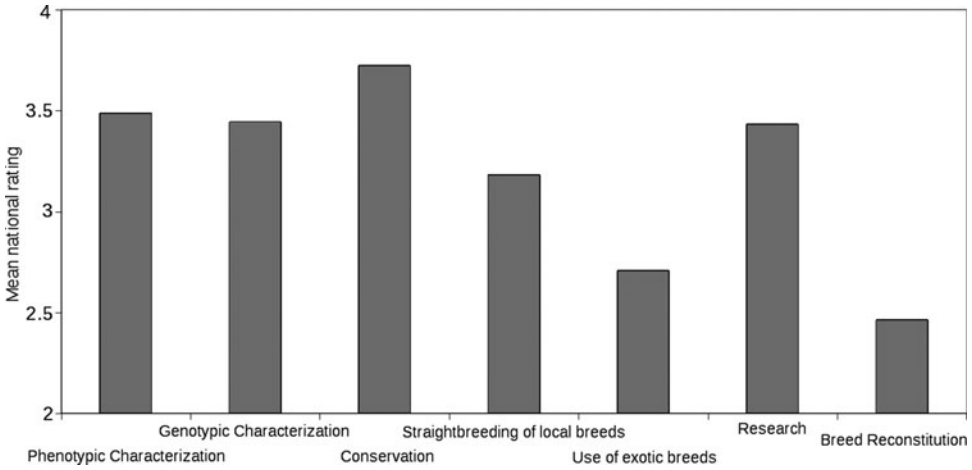

Figure 2. Importance by country of various activities in the management of AnGR (greater values indicate increased importance).

phenotypic characterization was considered significantly ($p < 0.05$) less important in North America than in any other region. Genetic improvement through the use of exotic breeds was considered by the respondents to be less important ($p < 0.02$) in North America and Europe than in any of the other regions.

One potential weakness of the question is that it may have created ambiguity with respect to some AnGR-related activities. For example, "upgrading" by the repeated use of exotic germplasm on locally present breeds is practised in many countries. The genetic improvement of the milk yield of local Holstein and/or Friesian populations in Europe by importation of germplasm from North American Holsteins has been important in the recent past and this practice could arguably be defined as either genetic improvement with exotic breeds or straightbreeding of local breeds, depending on whether the European and North American populations were considered to be distinct breeds or strains of the same breed. This example highlights the dilemma of distinctness where breeds have been moved across national boundaries and selected in a different environment and, possibly, for different traits or with different importance attached to the same traits. The Nellore in Brazil and Nellore/Ongole in India are another such instance.

In addition, the questionnaire did not address all AnGR-related activities. For example, the importance of crossbreeding existing local breeds with each other was not addressed. Crossbreeding of locally adapted purebreds is clearly widespread in beef and swine production in North America and other regions.

National conservation programmes

Table 3 shows the proportions of countries with different types of conservation programmes for the major livestock species. The questionnaire (Appendix 1) did not provide specific definitions for the different types of programmes, and so the results and discussion assume that respondents used a common set of definitions. For the record, *in situ* conservation was considered by the authors to mean the maintenance of AnGR in a sustainable manner in their natural production environments. *Ex situ–in vivo* conservation was assumed to refer to keeping live animals out of their natural production environment, such as in a government farm or breed rescue station. Cryoconservation was interpreted as storage of germplasm or other tissue in a gene bank.

In spite of possible variability in interpretation, a few general trends are clear. First, *in situ* conservation programmes are the most common, with approximately twice as many *in situ* programmes either *ex situ–in vivo* programmes or cryoconservation programmes. The numbers of these latter two types of programmes are generally similar, except for poultry species, yaks and rabbits, for which *ex situ–in vivo* programmes are more numerous. Not surprisingly, in general, the more common species (e.g. cattle,

Table 3. Proportions (percent) of countries reporting different types of conservation programmes for the major species of livestock.

Species	Type of conservation (%)		
	In situ	*Ex situ–in vivo*	Cryo
Buffalo	22	11	11
Camelids	14	7	2
Cattle	73	40	49
Chicken	48	34	10
Duck	31	16	3
Goat	58	31	30
Goose	29	12	3
Equines	41	21	20
Pig	37	24	20
Rabbit	23	17	6
Sheep	63	30	31
Turkey	17	9	2
Yak	4	3	0

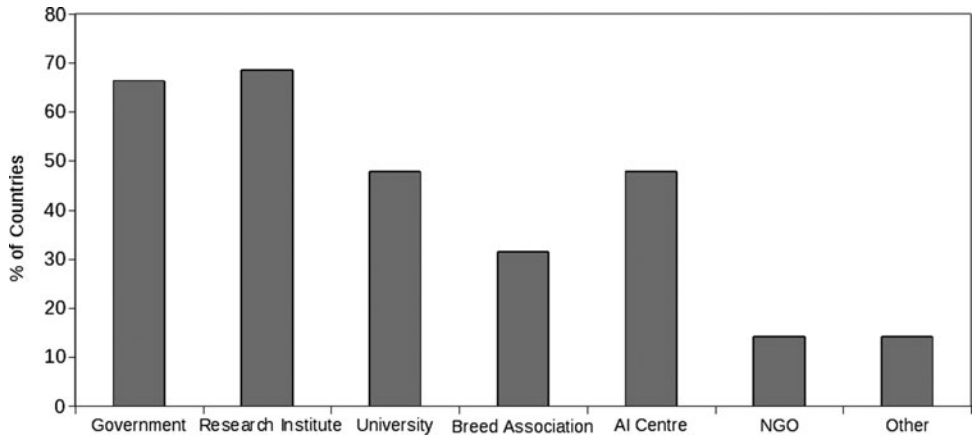

Figure 3. Proportions (percent) of countries in which various agencies are engaged in cryoconservation activities for AnGR.

sheep and goat) have more conservation programmes. Among the countries with responses, cryoconservation programmes are most common in North America, followed by Europe, and then Asia, the Near East, Africa and Latin America.

With respect to cryoconservation programmes in the various countries, Figure 3 shows the proportions of countries in which different agencies are engaged in the operation of cryoconservation programmes. The proportions do not add up to 100 percent, because some countries have multiple gene banks and because some of the categories overlap to some degree. Public institutions are the major operators of gene banks, directly through government agencies (66 percent), research institutions (68 percent) or universities (48 percent). Artificial insemination centres also play an important role in nearly half of the countries, and many such centres are government operated. In addition, in some countries, responsibilities may have been already assigned even if no cryoconservation programme is in operation. Figure 4 summarizes countries' plans for the operation of gene banks within the next 5 years. More than 30 percent of countries have no gene bank and no plans to create one within the next 5 years. Fully operational national gene banks are present in only about 18 percent of the countries. An equal number have established gene banking facilities, but have only a small number of accessions. The remaining countries have recognized the need for a local gene bank and are at various stages of planning.

Various factors must be overcome in the establishment of gene banks, and these factors can also hinder the smooth operation of existing gene banks. Figure 5 shows the importance of several of these factors, according to the perception of those responding to the survey. Financial factors were by far the biggest constraint, being cited in about 75 percent of the countries. Low priority in the national livestock policy and lack of infrastructure and technical capacity were all cited by around 50 percent of respondents. With respect to specific regions, the least obstacles were encountered in North America, with only low national priority being cited in Canada. Obstacles were similar in Europe and Latin America and were cited less often than in the remaining regions. This latter trend was particularly true for infrastructure

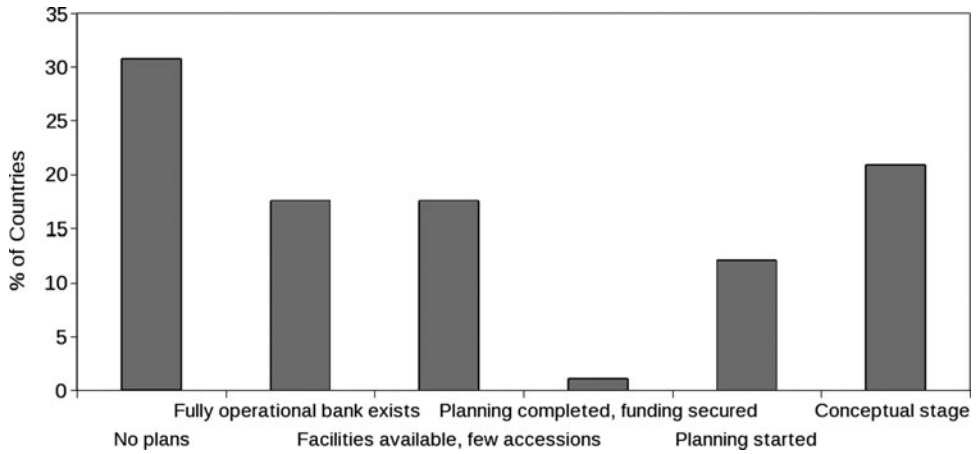

Figure 4. Proportions (percent) of countries with various expectations with regard to plans for the operation of gene banks for AnGR within the next 5 years.

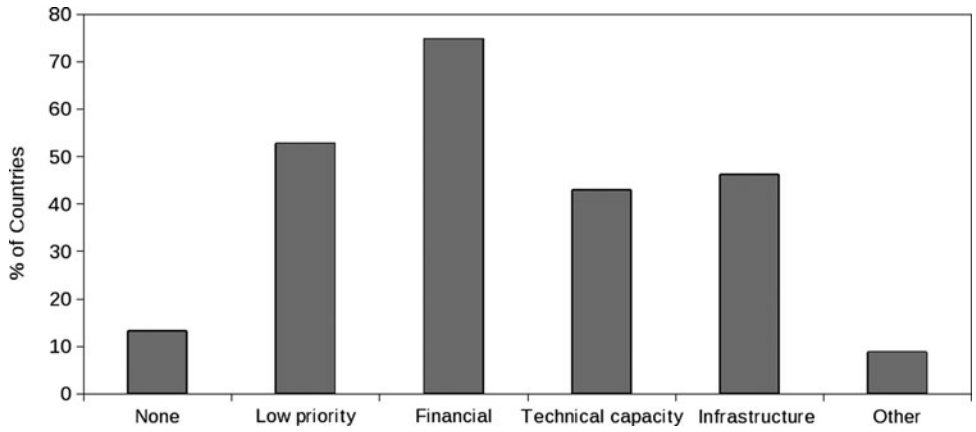

Figure 5. Proportions (percent) of countries facing various factors that hinder the establishment or operation of gene banks for AnGR.

and technical capacity, as these obstacles were each cited by about 30 percent of respondents in these two regions, versus 50–70 percent in Africa, Asia and the Near East.

Multinational cryoconservation programmes

According to the respondents in the survey, multinational backup storage systems for AnGR are essentially non-existent. Three countries reported to be the host of a multinational storage programme, the United States, Tunisia and Burkina Faso. Respondents from South Africa, Croatia and Slovakia reported that their countries contributed to a multinational system, but provided few details about the host country.

The paucity of multinational gene banks is not due to a lack of interest, at least according to the respondents to the questionnaire. Figure 6 shows the interest expressed in the different countries to participate in different types of gene banks, as either a host or a donor of genetic material. Among the possible scenarios, regional gene banks seem to be the preferred model. More than 60 percent of countries would be willing to host a regional gene bank and 40 percent would be willing to contribute. Bilateral and global gene banks were somewhat less appealing, with an interest to participate expressed in about 30 percent of the countries. Refusal to participate in any kind of multicountry gene banking was expressed by only about 10 percent of the countries.

Given that lack of interest is not a significant reason for a lack of multinational gene banks for AnGR, other factors must be responsible. Although the questionnaire did not address this issue in general, financial and logistical factors are surely among the constraints, given their importance with respect to the operation of national gene banks. International and national regulations are another important consideration. The influence of such regulations on the operation of gene banks is evaluated in depth in a companion paper in this special issue (Blackburn and Boettcher, 2010), and so only a brief summary will be presented here. According to the respondents, more than 70 percent of countries have regulations on health and

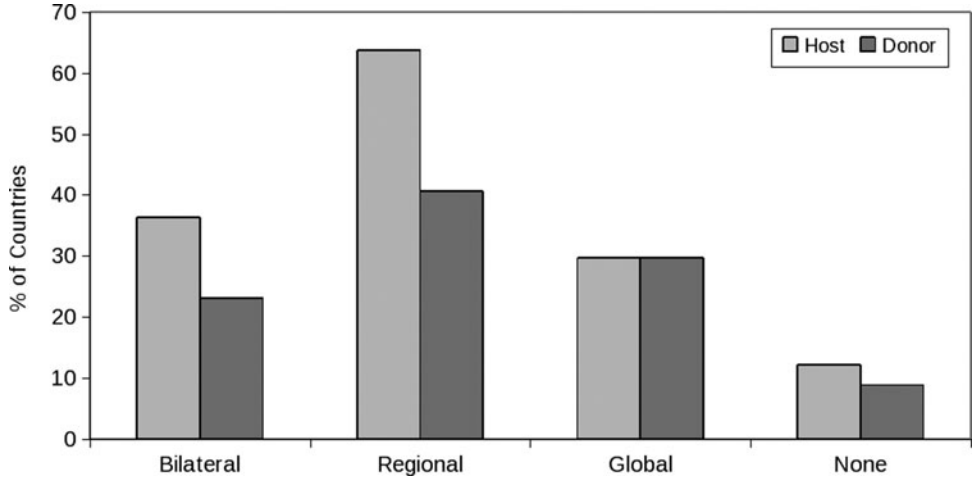

Figure 6. Proportions (percent) of countries expressing interest in participating as either a donor or a host to various types of multicountry gene banks for AnGR.

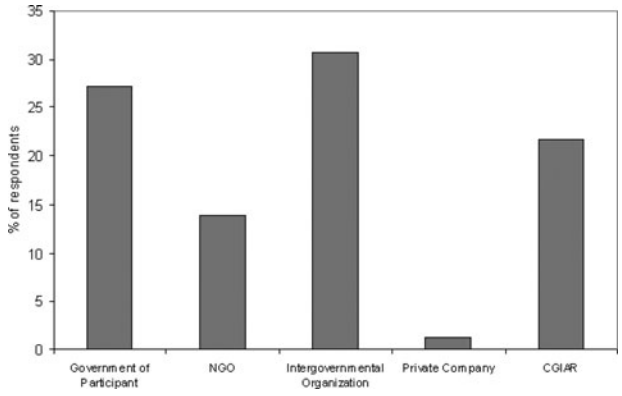

Figure 7. Preferences (percent) of respondents with regard to the host of a hypothetical multicountry gene bank for AnGR.

welfare of animals that would need to be considered for participation in multinational gene banking. About 40 percent of countries have legislation regarding the exchange of germplasm. In only about 25 percent of the countries were respondents unaware of any important regulations, but this percentage is likely to be an underestimation.

Assuming that the various obstacles could be overcome, the respondents expressed their preferences about the format and characteristics of a multinational gene bank for AnGR, as well as the conditions under which their respective countries would be willing to participate. With regard to a possible host of a multicountry gene bank, three types of hosts received considerable support (see Figure 7). The greatest number of respondents (31 percent) preferred that a multicountry gene bank be hosted by an intergovernmental organization, presumably for their neutrality and small likelihood to exploit the germplasm for commercial purposes. However, a similar proportion (27 percent) believed that the government of one of the participating countries would make the best host. The Consultative Group on International Agricultural Research was the host preferred by 22 percent of those responding, and although reasons were neither requested nor given, this preference is likely possibly due to their neutrality, technical capacity and past experience working with gene banks, particularly for plant genetic resources (e.g. Jackson, 1997; Gómez *et al.*, 2005). Much smaller proportions favoured NGOs or private companies as hosts.

The final question addressed the practical conditions under which countries would be willing and able to participate in a multicountry gene banking initiative. The first question dealt with the collection of the germplasm. A willingness and ability to collect the germplasm to be contributed to the multicountry bank was indicated for 77 percent of the countries, whereas the others would require assistance from outside in germplasm collection. The greatest level of willingness and capacity to collect germplasm was found in Europe, where the collection of national germplasm would be possible in 93 percent of countries (27 of 29). The differences among other regions were not significant ($p > 0.10$).

The second question regarded financial considerations. Not surprisingly, given the fact that lack of financial support was indicated as the most common obstacle for national gene banking, the proportion of respondents indicating willingness of their countries to pay for all costs of collecting and storing their animal germplasm in a multinational gene bank was somewhat low. Respondents from only 20 percent of countries indicated that their countries could fully support financially the participation in a collaborative gene-banking initiative. However, on the bright side, 57 percent of countries would be willing to share the costs associated with their participation. For only 23 percent of countries would outside funding be needed to support all activities. Despite the differences in the average economic status of countries in the different regions, no significant differences among regions were observed in terms of these financial considerations.

With respect to ownership of the germplasm deposited in a multinational gene bank, respondents from most countries (87 percent) expressed a desire for their countries to maintain at least partial ownership. Full ownership was considered a necessary condition for 34 percent of countries, whereas shared ownership was acceptable for 53 percent. No significant regional trends were observed.

There was no positive correlation between countries' opinion on who should pay for the gene banking and who should own the banked genetic material. In fact, the opposite trend was observed. For example, among the countries that would be willing to support all part of the costs of germplasm collection and storage, only about 30 percent (22 of 69) considered it necessary to maintain full ownership and 12 percent were willing to relinquish all ownership. On the other hand, among the 21 countries that would not contribute financially to gene banking, 43 percent wanted to nevertheless keep full ownership of the genetic material and only one expressed willingness to release all rights to the germplasm.

Comments

Respondents were also allowed the opportunity to make general comments at the end of the questionnaire. Among the sentiments that were voiced multiple times was that there is a lack of capacity and resources in many developing countries, and so international cooperation on gene banking is necessary, whether it be in the form of establishing multinational gene banks or providing technical and financial assistance for the creation of national gene banks. Several other persons noted that national gene banks may be a logical first priority for many countries, given the complexity of organizing, financing and operating multicountry banks.

Conclusions

Several conclusions can be drawn from the evaluation that was undertaken in this study. A wide interest in gene banking of AnGR was expressed by the persons completing the questionnaire. However, the respondents were clearly a biased sample, with more knowledge than the average person about the importance of AnGR and likely a greater vested interest in support of activities dealing with their management and conservation. One problem is that policymakers and the general public are less informed about the importance of AnGR. This lack of knowledge is likely contributing to obstacles that hinder the implementation of AnGR management activities, such as gene banking. For example, there is often insufficient funding for such activities, and management of AnGR is often not given high priority in national livestock and agricultural policies. If AnGR were considered more important by policymakers and the general public, then perhaps more public funding would be made available to ensure their improved management. In many countries no national gene bank exists. Various agencies within the same countries have thus accepted the responsibility for operating their own independent banks.

With regard to multicountry gene banking, the respondents generally expressed interest in their country's participation in such an endeavour. Despite this fact, few multicountry gene banks for AnGR are actually operating. Among the probable reasons for the lack of such gene banks are restrictions imposed by national and international legislation and health and sanitary regulations and national policies on exchange of genetic resources. In addition, a lack of funding and differing opinions among countries on who should pay for collection of germplasm and on the ownership of stored material also impede the creation of multinational gene banks for AnGR.

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Appendix 1. Questionnaire on the current arrangements for existing regional AnGR storage systems and regulations

1. Contact Information

- First name: _____
- Last name: _____
- Name of organization: _____
- Email address: _____

2. Please indicate your country _____

3. Are you a National Coordinator for the management of animal genetic resources (AnGR)?

- Yes
- No

4. What is your role in AnGR management within your country? (Main occupation)

- Government Official
- Research and/or Teaching
- Industry
- Breeder
- NGO
- Other

5. Which activities do you consider most important for AnGR management in your country?

Activity	Very important	Important	Somewhat important	Not important
Phenotypic characterization of local breeds	□	□	□	□
Genetic and molecular characterization of local breeds	□	□	□	□
Conservation of local breeds	□	□	□	□
Genetic improvement through straightbreeding of local breeds	□	□	□	□
Genetic improvement through well-managed use of exotic breeds	□	□	□	□
Research and development on AnGR conservation methods	□	□	□	□
Reconstitution of extinct breeds from a cryobank	□	□	□	□

6. Do you think that the importance of AnGR conservation is well understood by the following stakeholders in your country?

Stakeholders	Yes	Partially	No
Policy makers	□	□	□
Researchers	□	□	□
Farmers and breeders	□	□	□
General public	□	□	□

7. Does your country have national conservation programmes for AnGR?

Species	in situ	ex situ in vivo	ex situ - in vitro (cryo)
Buffalo	□	□	□
Camelids	□	□	□
Cattle	□	□	□
Chicken	□	□	□
Duck	□	□	□
Goat	□	□	□
Goose	□	□	□
Equines	□	□	□
Pig	□	□	□
Rabbit	□	□	□
Sheep	□	□	□
Turkey	□	□	□
Yak	□	□	□

8. Which bodies are responsible for cryoconservation of AnGR in your country?

- Government
- Research institute
- University
- Breeders' organization
- AI Centre
- NGO
- Other _____

9. Are there any plans to have a national gene bank for AnGR within the next 5 years?

- NO, not that I am aware of
- YES, our country already has a fully operational gene bank for AnGR
- YES, our country has established facilities for a gene bank, but no or few samples have been collected
- YES, all steps for preparation and funding are in place
- YES, formal planning is being undertaken
- YES, but planning is only at the conceptual stage

10. Which obstacles hinder the establishment and maintenance of a national gene bank for AnGR? (Multiple selection)

- No obstacles
- Lack of priority in national livestock policy
- Lack of financial resources
- Lack of technical capacity
- Lack of infrastructure
- Other_____

11. Is your country a party to a multicountry back-up storage system for AnGR?

- NO, not that I am aware of
- YES, host of a multi-country back-up system
- YES, donor of germplasm

If yes, please indicate host and other countries involved

12. If not, is there a willingness to participate (as a host or donor) in a multicountry AnGR conservation programme?

Role	Bilateral	Regional	Global	No
Host	□	□	□	□
Donor	□	□	□	□

13. Are there any national regulations for the exchange of AnGR that might be relevant for regional gene banking? (Multiple selection)

- NO
- YES, legislation on genetic material exchange
- YES, animal health and welfare related regulations
- YES, legally-binding contracts between gene banks and providers
- Other _____

14. Which would be your preferred host of a regional gene bank?

- Government of a participating country
- Non-commercial non-governmental organization
- Intergovernmental organization
- Private company
- Consultative Group on International Agricultural Research (CGIAR)
- Other_____

15. Which of the following sets of conditions would be acceptable for your country's participation as a germplasm donor in a regional gene bank for AnGR?

a. Collection of germplasm
   - Donor county collects germplasm
   - Host or other agency collects germplasm

b. Financial support for collection and storing
   - Donor pays all costs
   - Donor shares costs
   - Donor pays no costs

c. Ownership of germplasm
   - Donor country maintains full ownership
   - Host obtains unconditional ownership
   - Host has ownership, but Donor has the first rights to repurchase
   - Donor and Host share ownership, with specified conditions
   - Outside agency gains full or conditional ownership

16. Do you have any additional comments, ideas or suggestions? _____

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Where's the beef? The economics of AnGR conservation and its influence on policy design and implementation

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Summary
The field of economics of agrobiodiversity (ABD) conservation and sustainable use has developed rapidly during recent years. A state-of-the-art review found that advances have indeed eased methodological/analytical constraints. A wide range of decision-support tools and analytical approaches have been successfully tested. These have been shown to provide good estimates of value and be useful for answering policy-relevant questions.

Yet despite this, this field would appear to have had relatively little influence on "real-life" ABD conservation policy design and implementation. An analysis of the national reports in the FAO's (2007) State of the World's AnGR (SoW) supports this view and reveals, at best, a patchy recognition of the importance of valuation and the potential future role of economics in the design of cost-effective conservation programmes. Potential reasons for this include a lack of awareness regarding the existence of appropriate methods and decision-support tools, data availability issues and a lack of capacity to both collect the necessary data through participatory mechanisms as well as to carry out the subsequent analysis. Translating the existing recognition of the importance of economics within the Global Plan of Action on AnGR into a mainstream activity will require significant awareness raising and capacity building.

Keywords: *Economics, AnGR conservation, impact, policy design*

Résumé
Le domaine de l'économie de la conservation et de l'utilisation durable de la biodiversité agricole s'est rapidement développé au cours des dernières années. Un examen de l'état actuel des réalisations a indiqué que les progrès ont effectivement diminué les contraintes méthodologiques et analytiques. Un large éventail d'outils d'aide à la prise de décisions et d'approches analytiques ont été testés avec succès et ont montré qu'ils peuvent fournir des estimations adéquates de la valeur et être utiles pour répondre aux questions relatives aux politiques.

Pourtant, malgré cela, il semblerait que ce domaine ait eu une influence relativement faible sur la conception et sur la mise en œuvre de politiques concrètes de conservation de la biodiversité agricole. L'analyse des rapports nationaux soumis pour la préparation de L'état des ressources zoogénétiques dans le monde (2007) de la FAO soutient ce point de vue et révèle, au mieux, une reconnaissance irrégulière de l'importance de l'évaluation et du rôle potentiel, à l'avenir, de l'économie dans la conception de programmes de conservation rentables. Les raisons potentielles de cette situation sont, entre autres, le manque de sensibilisation concernant l'existence de méthodes appropriées et d'outils d'aide à la prise de décisions, les problèmes relatifs à la disponibilité des données et le manque de capacités tant dans la collecte des données nécessaires par le biais de mécanismes participatifs que dans la réalisation des analyses ultérieures. Pour transformer la reconnaissance actuelle de l'importance de l'économie dans le cadre du Plan d'action mondial pour les ressources zoogénétiques en une activité de premier plan, il faudra entreprendre des actions de sensibilisation et de renforcement des capacités considérables.

Mots-clés: *Economie, conservation des ressources zoogénétiques, impact, conception de politiques*

Resumen
El campo de la economía de conservación y utilización sostenible de la agrobiodiversidad se ha desarrollado rápidamente a lo largo de los últimos años. Una revisión del estado de las tecnologías de vanguardia ha evidenciado que los avances han dado pie a limitaciones metodológicas y analíticas. Se han probado con éxito una amplia variedad de herramientas para la toma de decisiones y enfoques analíticos. Éstos se han mostrado para proporcionar buenos cálculos de valor y para ser útiles a la hora de responder a las cuestiones políticas pertinentes.

Pero a pesar de esto, este campo parecería haber tenido relativamente poca influencia sobre el diseño e implementación de la "vida real" de políticas de conservación de la agrobiodiversidad. Un análisis de los informes nacionales en la Situación de los Recursos Zoogenéticos Mundiales para la Alimentación y la Agricultura de la FAO (2007) apoya esta visión y revela, en el mejor de los casos, un desigual reconocimiento de la importancia de la valoración y el potencial futuro papel de la economía en el diseño de

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programas rentables de conservación. Las razones potenciales para esto incluyen la falta de conciencia relativa a la existencia de métodos adecuados y herramientas para la toma de decisiones, disponibilidad de datos y falta de capacidad, tanto para recopilar los datos necesarios, por medio de mecanismos de participación, como para llevar a cabo análisis posteriores. Extrapolando el reconocimiento existente acerca de la importancia de la economía dentro del Plan de Acción Mundial sobre los recursos zoogenéticos para una actividad dada, se requerirán grandes dosis de concienciación y creación de capacidad.

Palabras clave: *Economía, conservación de AnGR, impacto, diseño de políticas*

Submitted 29 March 2010; accepted 17 June 2010

The economics of AnGR conservation

Animal genetic diversity contributes in many ways to human survival and well-being. In spite of its importance, livestock diversity continues to be lost from many production systems throughout the world. Sixteen percent of livestock breeds were lost over the last 100 years and over 20 percent of the remainder are at risk. Such AnGR erosion is much more serious than in crops given that the gene pool is much smaller (6 000–7 000 breeds/strains of some 40 species) and the fact that there are few wild relatives. Major reasons for this loss include indiscriminate breed substitution and replacement, changes in productions systems, changes in consumer preferences, market development and globalization, misguided government interventions (including subsidies), disease epidemics, natural disasters and civil strife (Hall and Ruane, 1993; Rege and Gibson, 2003; FAO, 2007).

For ecological economists, such loss is the result of a conversion process (Swanson, 1997) from diverse to specialized production systems that allow different types of economic value to be more easily appropriated by humans and hence underlies the process of economic growth. However, this conversion process may go well beyond its optimum point due to the fact that the goods and services provided by agrobiodiverse resources have significant non-market values associated with them. The inadequate assessment of the total economic values of indigenous breeds (i.e. beyond just meat and milk production, but also including manure, traction, finance and insurance functions, socio-cultural values and future option values – e.g. for confronting future climate change and new diseases) means that the (private) financial profitability and the (public) economic value to society as a whole of indigenous breeds is frequently underestimated. This generates a bias towards investment in specialized genotypes, which in turn results in underinvestment in a more diverse set of breeds.

Farmers nevertheless cannot be expected, nor can afford, to safeguard public good values (e.g. the conservation of unique genes and breeds for their global/national option and existence values) without the appropriate incentives to do so. The fact that such incentives are largely absent or even heavily biased towards non-indigenous breeds (a below average $265 billion was spent on support to producers in the OECD area in 2008 [OECD, 2009, p. 5]) is a failure of national policy frameworks, as well as associated underfunding and lack of capacity. The existence of both bias and a lack of incentives means that as the development process proceeds and farmers can afford more and often subsidized inputs (e.g. fertilizers, mechanization, feed, veterinary care artificial insemination and transport to market), they will find it profitable to move away/convert from using breeds (usually indigenous) appropriate for low-input/low-output systems. Furthermore, they will tend to do so at a much earlier point in the development process than they would have otherwise and may even do so in inappropriate situations (Drucker and Rodriguez, 2009).

Effective policies to stem this loss require improved tools and the capacity to both properly account for the values associated with the services and benefits derived from agrobiodiversity (ADB), as well as to design appropriate instruments to capture such values. The capture and channelling of such values back to the local level in the form of conservation incentives[1] are necessary to overcome a spatial mismatch, where conservation costs incurred are largely local, whereas the benefits are often national and global. Without such tools, cost-effective interventions can neither be designed nor implemented. Economic analysis might be expected to play an important role in orienting such policy design and implementation, including with regard to: (i) Determining which traits and functions (both marketed and non-marketed) are the most important and to what extent can they be traded off against each other? (ii) How important particular local breeds are to livelihoods and how such values can be harnessed to support poverty alleviation efforts? (iii) Which breeds should be conservation priorities (given that we cannot save everything)? (iv) What the costs of ABD conservation programmes are and how we can minimize them?

State of the art

Spurred by the growing concern regarding genetic resource erosion and in order to address such questions, the field of

[1] The utility of one such incentive mechanism is being explored through on-going work at Bioversity International related to the application of payment for environmental services concepts to ABD conservation *per se*.

economics of ABD conservation and sustainable use has developed rapidly during recent years, with the applied economics literature related to plant genetic resources (PGR) having a somewhat longer history than that of AnGR. A state-of-the-art review (Drucker, Smale & Zambrano, 2005; Smale and Drucker, 2007[2]) of the literature, commissioned by the CGIAR's System-Wide Genetic Resources Programme, covered over 170 publications (both livestock and plants). See also the SoW (FAO, 2007, pp. 429–442) for an additional review of the AnGR economics literature. These reviews found that advances in economic valuation have indeed eased methodological/analytical constraints. A wide range of decision-support tools and analytical approaches have also been successfully tested on a number of crops/species and breeds, in a number of production systems and locations, both *in situ* and *ex situ*. An impressively lengthy list of these tools and methods includes: econometric methods; optimization models (including Weitzman); Monte Carlo simulations; search theoretic frameworks; contingent valuation and choice experiments; production loss, opportunity cost, least-cost and safe minimum standards methods; economic surplus methods; cross-sectional farm and household methods; farm simulation and breeding programme evaluation; and the use of genetic production functions. This body of research consequently provides a useful, but as yet largely unapplied, framework of knowledge on the ways in which improved valuation of the components of ADB (i.e. crop, livestock, forest and aquatic) can contribute to optimal investment allocations and policy decisions.

Yet despite the apparent policy relevance of economics in supporting ABD policy, there would appear to be relatively little uptake and use of such tools and methods. Consequently, the influence of economics in ABD conservation policy[3] design and implementation appears to have been limited to date.

National reports and the economics of AnGR conservation and use

An examination of the 174 SoW national reports (FAO, 2007) tends to confirm this view. The limited influence may be considered within the context of the following two types of economic analysis: (a) economic characterization (e.g. value of productive and adaptive traits; contribution to livelihoods) and (b) cost-effective conservation policy (prioritization of what to conserve and types of intervention mechanism). Consequently, we considered the following key words as search terms.

[2] Available at www.bioversityinternational.org/fileadmin/bioversity/publications/pdfs/1060.pdf. For an annotated bibliography and searchable database of the applied AnGR and PGR economics literature (last updated 2008) see http://ifpri.catalog.cgiar.org/ecogenlit.htm.

[3] Considered distinct from the frequent consideration of economics and market values in commercial breed improvement programmes.

Economic valuation

A search for key words relating to "economic valuation", "economic value", "evaluation" and "valuing" reveals less than ten relevant country-distinct references, all of which largely refer to the importance of carrying out such valuation work in the future.

For example, Germany (Sections 2.3.3 and 2.3.4, p. 18) recognizes the range of economic and ecological values that make up the total economic value of AnGRs. Indonesia (Section 4.1.1. Awareness, p. 23) notes that there is "an urgent need to undertake realistic economic valuation of farm domestic animal genetic resources so that their economic and social significance is realized. This would also help bring the issue of conservation of farm domestic animal genetic resources into the mainstream of national program aimed at improvement of livestock productivity." Similarly, Pakistan (p. 14 and elsewhere) notes that work on economic valuation is limited but is needed to draw attention to the socio-economic significance of these resources thereby helping to bring the issue of conservation of AnGR into the mainstream of national programmes aimed at improving livestock productivity, with increased awareness expected to convince policy-makers to allocate more funds for conservation and better utilization of AnGR (p. 24). A call for international assistance specifically mentions breed characterization (phenotypic and genetic) and economic valuation (p. 30). The limited use of economic valuation is also mentioned in The Netherlands (Section 4.2. Policy Priorities, p. 58), which notes that "in general, the insight into the value of old breeds and conservation of genetic diversity is quite limited, or the value has a limited definition. An increase in appreciation and valuation of economic, ecological, cultural and historical values is required." Similarly, Malaysia (Section 3.3. Alternative Strategies [not yet feasible], p. 48) notes that future strategy should include exploring options for funding mechanisms (e.g. a tax on animal and animal product imports or tax incentives for livestock conservation and AnGR development activities) and the "undertaking of economic and technical studies to evaluate marginal breeds with economic value thus encouraging the conservation of threatened breeds". Fiji (p. 29), Kiribati (p. 30), Samoa (p. 43), Dominica (p. 21) and Syria (p. 40) all recognize the "economic valuation of breeds" as one of the priorities for future characterization work. The United States (Section 4, p. 35) considers that continued development of the National Animal Germplasm Program also requires understanding "the current and future economic valuation of genetic resources".

Prioritization and cost-effectiveness

A search for key words relating to "prioritisation/prioritization/priority", "cost-effective/cost effective" and

"Weitzman"[4] also reveals less than ten relevant country-distinct references.

The United Kingdom (Sections 4 and 5, various pages) recognizes the importance of prioritization, noting that "because resources are limited, prioritisation of breeds is necessary". Although recognizing the existing rare breed categorization, it is considered that additional criteria such as distinctiveness and local adaptation might also usefully be used to prioritize breeds at risk which are not necessarily rare but may still need to be conserved. Greater national-level coordination, as well as cooperation at the European and international level to ensure that conservation activities are managed cost effectively (pp. 3–4) is also mentioned. Similarly, Iran (Section 5) also notes the future importance of "identification, evaluation and prioritization of native breeds in every country, region and even at global level to achieve more effective conservation programmes of native AnGR." Germany mentions cost effectiveness a number of times, including in Section 4.1. Objectives (p. 45) noting the requirement of "long term *in-situ* and *ex-situ* conservation of the diversity of animal genetic resources by means of scientifically underpinned and cost-effective programmes". As part of Finland's National AnGR Programme (p. 46), it is considered that the most important form of conservation is the keeping of live animals (*in situ* conservation) and that the most cost-effective way is to keep using animals for production purposes and to improve their use in production.

However, having mentioned the importance of prioritization and cost effectiveness, there is but a single mention of the Weitzman[5] approach. Germany (pp. 59–60) notes that "one relatively new research area involves economic assessment of strategies for the conservation of genetic diversity, as explored by Weitzmann (1992 and 1993)". Research priorities for the implementation of this approach in current conservation programmes include the following:

- The identification of base parameters to present reliable functions between conservation efforts and yields in genetic diversity.
- Relative economic weighting of within-breed diversity, current production value and special performance of the endangered breeds.
- Expansion of the analysis approach to include consideration of diversity within and between breeds.

[4] The Weitzman approach is a specific prioritization decision-support tool that attempts to address "the Noah's Ark question" of how to prioritize. According to Weitzman (1992, 1993) and an AnGR application by Simianer *et al.* (2003), it is possible to combine measures of diversity, current risk status and conservation costs so as to permit the identification of a cost-effective diversity-maximizing set of breed conservation priorities. Hence, for any given quantity of conservation funding available, it is possible to identify a priority conservation portfolio that maximizes the diversity than can be conserved, thereby providing an answer to "which breeds should we take on-board the Ark?"

[5] "Weitzman" is used here as a proxy for diversity-maximizing cost-effective optimization models in general. While some authors have suggested improvements to the diversity metric suggested by Weitzman (e.g. to take account of intra-breed diversity) (Ollivier and Foulley, 2005), the overall method is robust and can be applied using a number of alternative diversity measures.

Subsidies and compensation

A search for key words relating to "subsidy/subsidize/subsidise" and "compensation" payments for conservation again reveals less than ten relevant country-distinct references. Although it is recognized that there are many more active AnGR-support programmes than this (particularly across the EU), many lack accounting for the degree of threat faced and provide subsidy levels too low to cover farmer opportunity costs (Signorello and Pappalardo, 2003).

The free-market view is exemplified by the United States (p. 24), which notes that "given the lack of subsidy programs and the relatively rapid contraction of some genetic resources in the livestock sector, the development of cryopreserved collections needs to proceed immediately. Such an effort may be the most cost effective mechanism to protect and preserve genetic diversity." Section 2.3 (Strategies) notes that "there is no legislation which provides producers with a subsidy for raising minor, rare or endangered breeds. Therefore, for unique genetic resources to remain stable or increase in usage they will have to compete in the marketplace. While, at this point in time, some breeds may have difficulty in competing, changes in consumer preferences may encourage the raising of diverse breeds." Section 2.4 (Future Policy) goes on to note that "subsidies for rare or unique genetic resources are not viewed as an effective conservation strategy. Rather, market forces are the major driving variable controlling genetic resource utilization."

However, given that the scale of agricultural subsidies means that such market forces are likely to be distorted and, together with the widespread recognition of the many non-market values encapsulated within the total economic value of AnGR, there would appear to be strong arguments for interventions that help to at least level the playing field somewhat. Germany (Section 3.1.2. Breeding Associations) considers that both the Animal Breeding Act and the relevant authorities lack defined rules related to the obligation and commissioning of breeding organizations at adequate levels of compensation to undertake socially desired conservation responsibilities alongside their actual breeding-related activities. There is thus an urgent need to establish special legislation on the conservation of animal genetic resources and to set out nationwide provisions that are currently lacking. Latvia (Section 4.3. Needs for Use and Development of AnGR, p. 24) considers that to prevent disappearance "breeders that rear native breeds must receive compensations for the difference between the indigenous, less productive breeds and imported high productive breeds." Sweden (Section 6.3. Targeted measures, p. 43) argues that "particularly threatened breeds, should be conserved as this forms part of the conservation of genetic resources, which is a national responsibility. In the case of breeds where the financial returns for managing and breeding them are small, special incentives may be needed to

maintain population size and to support the breeders' associations in their work. The only incentives currently provided in support of conservation efforts are compensation grants for endangered breeds. No priorities have been established other than the actual classification of certain breeds as threatened[6]. Little evaluation or comparison of existing breeds to ascertain their distinctive characters or identify potentially interesting traits is carried out". Finally, The Netherlands (Section 2.1. Lessons from the past, p. 38) recognizes that 'the Government has formulated very little policy regarding *in situ* farm animal conservation. Apart from a limited subsidy scheme for rare breeds of farm animals, *in situ* conservation is left to private initiative'. There is also the difficult matter of deciding 'whether animals from the same or similar breed in another country should be taken into account during the subsidy decision' (p. 64).

Discussion and conclusion

A wider number of economics-related search terms may increase the number of identifiable relevant references in the national reports. There may also have been further developments since the elaboration of the national reports in 2001–2007. Nonetheless, based on the current evidence, it is clear that the consideration of economic analyses and the underlying methods and decision-support tools is patchy at best. Furthermore, those references that do exist, while revealing some awareness of the importance of such analyses and its potential contribution to characterization and cost-effective prioritization activities, tend to highlight the importance of such applications in the future rather than in the context of current policy design and implementation. The existing compensation payments tend to ignore measures of distinctiveness (potentially making interventions inefficient) and can be insufficient to cover opportunity costs.

These and other significant gaps in the capacity to manage AnGR were identified in the SoW AnGR (FAO, 2007). In response, the international community adopted the Global Plan of Action for Animal Genetic Resources (GPA), which includes 23 strategic priorities for action grouped into four priority areas: (1) characterization and monitoring; (2) sustainable use and development; (3) conservation; and (4) policies, institutions and capacity building. A number of these recognize the important role that the economics of AnGR conservation can play. Direct references can be found under the following actions:

- 1.2.1[7] (Standards and protocol development): Develop agreement on methods to assess environmental, socio-economic and cultural factors related to animal genetic resources management.
- 1.2.2 (Standards and protocol development): Including in the context of the assessment of comparative breed performance in different production environments, development of methods for the assessment of functional traits and economic valuation.
- 2.3.2 (Policy strengthening): Develop, as necessary, national policies that incorporate the contribution of animal genetic resources to sustainable use, which may include (. . .) conducting economic and cultural valuation of animal genetic resources.
- 2.6.1 (Support indigenous and local production systems): Assess the value and importance of indigenous and local production systems.
- 3.7. Rationale (establish national conservation policies): Policies should serve to ensure the maintenance of animal genetic resources with direct values for human use, including production, ecological, social and cultural values, as well as option values for future use and adaptation. Production and functional traits, and national capacity, should be taken into consideration in setting conservation priorities.

Potential reasons for limited uptake and influence

From the above, it is clear that a *lack of awareness* may only be partly responsible for the limited uptake and influence of the economics of conservation on actual policy design and implementation. At the international level (e.g. in the SoW report and the GPA), there is clearly a recognition that economics does indeed have an important role to play. However, relatively few national reports document actual application or explicitly recognize the importance of applying such methods and concepts in the future. Hence, there would appear to be a need under the GPA's capacity-building activities to further raise awareness among relevant stakeholders regarding the existing work that has been carried out in this field and how to apply it. Stakeholders include not only policy-makers but also aid agencies, NGOs, national agricultural research and extension agencies etc.

Even where such awareness exists, there may well be a *lack of capacity* to carry out relevant research and/or consider existing work when ABD conservation policy is being designed or implemented. There are relatively few people with an economics of conservation background within national livestock programmes. Even at the international level, this is the case. For example, within the CGIAR there are only a handful of scientists working on economics of genetic resources issues (even when considering both AnGR and PGR). Given that there are so few people in key positions at national levels with an appropriate economics background, there would appear to be a strong argument for related training with national livestock development programme personnel to be carried out in a way appropriate for personnel with non-economics backgrounds. Additional support could be provided through facilitating access to and strengthening national/international research hubs that can provide analytical expertise when necessary.

[6] As already noted above by Signorello and Pappalardo (2003).
[7] Strategic Priority Area 1, Strategic Priority 2, Action 1. Subsequent item numbers also follow the same coding.

An additional closely related reason relates to a *lack of data*. Data for economic analysis are either not available or perceived as expensive to obtain, perhaps also contributing to a (mis)perception that the tools are too technically complex to apply. There are also cases where data exist (e.g. related to distinctiveness) but has not crossed disciplines and been applied within an economic context (e.g. the Weitzman decision-support tool). However, data considerations mainly arise as there is a lack of availability of data related to farmers' preferences for different genetic resource attributes and the value placed on these across breeds and production systems. Until breed-level data are routinely collected as part of the national statistics, there will continue to be a need to undertake intensive primary data collection. This is likely to require the application of participatory rural appraisal techniques, for which once again capacity is limited in many countries.

Finally, we hypothesize that there are *multiple deficiencies* impeding the uptake of economic tools and methods. ABD conservation programmes tend to be deficient in their design as a result of a lack of consideration of a broad range of technical issues, of which economics is just one. The national reports and GPA would tend to confirm this view as future characterization strategies identify priorities that not only go well beyond economic valuation, but also include molecular analysis, performance measuring and monitoring. Given that economics of AnGR work is best carried out within a production systems' context and requires informational inputs from a range of disciplines, overcoming other deficiencies influencing the conservation and use of AnGR will also play a contributory role.

Conclusions

Despite the conceptual basis having been developed for important economic methods and decision-support tools, the challenge remains for such multidisciplinary multimethodology approaches to be applied widely to the issue of AnGR conservation and sustainable use, especially within the context of ongoing conservation policy design and implementation.

Until we do so, the world will continue to lose its local livestock breeds at an alarming rate due to a lack of informed decision-making and the elaboration of effective policy frameworks. The inefficient use of scarce conservation resources is particularly worrying as, in some cases, genetic erosion is occurring because of the lack of relatively small amounts of funding to provide the required conservation incentives to maintain even just an unthreatened (i.e. safe) minimum population (Drucker, 2006). The creation of mechanisms to provide such incentives are urgently needed, including through an exploration of the effectiveness of AnGR-focused payment for ADB conservation services schemes.

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Options and legal requirements for national and regional animal genetic resource collections

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Summary
The contraction of animal genetic resources on a global scale has motivated countries to establish gene banks as a mechanism to conserve national resources. Gene banks should establish a set of policies that ensure they are complying with national laws. The two primary areas of consideration are how gene banks interact with the owners of the livestock from which they are collecting samples and the relevant national or international health standards. With respect to dealing with livestock breeders for the purpose of germplasm acquisition, private property rights are the most common legal issue that will come into consideration while building collections and distributing stored material. National animal health standards may determine which animals may or may not be collected and to what extent the germplasm can be used. Internationally, the country's overall health status will determine the type of testing necessary before, during and after collection to ensure the movement of germplasm across international boundaries and through the normal protocols of animal germplasm transfer. Policy-makers will need to evaluate if the current structure of the World Organization for Animal Health (OIE) regulations will allow the development of bilateral backup collections or if waivers should be given to facilitate the genetic security afforded through gene banking.

Keywords: *Animal genetic diversity, gene bank, gene banking regulations, animal health*

Résumé
La réduction des ressources zoogénétiques à l'échelle mondiale a poussé les pays à créer des banques de gènes en tant que mécanisme de conservation des ressources nationales. Les banques de gènes devraient établir un ensemble de politiques garantissant leur conformité aux lois nationales. Les deux domaines principaux à prendre en considération sont les façons dont les banques de gènes interagissent avec les propriétaires des animaux d'élevage fournissant les échantillons et les normes sanitaires pertinentes au niveau national ou international. Pour ce qui concerne la gestion des sélectionneurs aux fins de l'acquisition du matériel génétique, les droits relatifs à la propriété privée représentent la question juridique la plus courante à prendre en considération lors de la création des collections et de la distribution du matériel stocké. Les normes nationales relatives à la santé animale pourraient décider des animaux pouvant ou ne pouvant pas être collectés et le niveau auquel le matériel génétique peut être utilisé. Au plan international, l'état sanitaire général du pays déterminera le type de contrôle nécessaire avant, pendant et après la collecte pour garantir la circulation du matériel génétique à travers les frontières internationales et selon les protocoles courants du transfert de matériel génétique. Les décideurs devront évaluer si la structure courante des règlements de l'OIE permet le développement de collections bilatérales de réserve ou s'il faut prévoir des dérogations afin de faciliter la sécurité génétique obtenue par le biais de la mise en place des banques de gènes.

Mots-clés: *diversité zoogénétique, banque de gènes, règlements relatifs à la mise en place des banques de gènes, santé animale*

Resumen
La contracción de los recursos zoogenéticos a escala mundial ha llevado a los países a crear bancos de germoplasma como mecanismo para conservar los recursos nacionales. Los bancos de germoplasma deben establecer un conjunto de políticas que garanticen que se están cumpliendo las leyes nacionales. Las dos principales áreas para tener en cuenta son la forma en que los bancos de germoplasma interactúan con los propietarios del ganado del que se toman las muestras y las normas sanitarias nacionales o internacionales pertinentes. Con respecto al tratamiento de los ganaderos con el propósito de adquirir germoplasma, los derechos de propiedad privada son la cuestión jurídica más común que se tendrá en cuenta, además de la creación y difusión de colecciones del material genético almacenado. En base a las normas nacionales de sanidad animal se puede determinar de qué animales se puede o no se puede obtener muestras y en qué medida se puede utilizar el germoplasma. A nivel internacional, el estado sanitario general del país va a determinar previamente el tipo de pruebas necesarias, durante y después de la obtención para asegurar el movimiento del germoplasma de un país a otro, y por medio de los protocolos normales para la transferencia de germoplasma animal. Los responsables del desarrollo de políticas tendrán que evaluar si la actual estructura de las normas de la OIE permitirán desarrollar colecciones de apoyo bilaterales o si la renuncia se debe dar para facilitar la seguridad genética que ofrecen a través de bancos de germoplasma.

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Palabras clave: *diversidad genética animal, banco de germoplasma, normas para el almacenamiento de germoplasma, sanidad animal*

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Introduction

As the international community has become concerned about the status and fate of animal genetic resources (AnGR), a number of countries have turned to gene banking semen, embryos or tissues for the purpose of safeguarding these resources. The need for such conservation measures is necessary given the decline in genetic variation among and within breeds of livestock (FAO, 2007a). Driving much of the contraction in genetic resources is the inability of certain breeds to be economically competitive under current market conditions that exist in their respective countries. This situation is not likely to change in the short term owing to the increasing demand for livestock products and the need to mitigate environmental pollutants generated by the livestock industry (Steinfeld *et al.*, 2006). In addition, *in situ* maintenance of populations is costly and vulnerable to negative perturbations to populations and the environment they are maintained within (Gollin and Evanson, 2003).

In principle, the concept of gene banking animal tissues is similar to the plant gene banks that have been in operation since the 1950s (NRC, 1993a). Since 2000, there has been a substantial increase in the number of gene banks storing AnGR (Danchin-Burge and Hiemstra, 2003; Blackburn, 2009). Furthermore, at a workshop on gene banking AnGR held in Tunisia more than half of the 25 countries in attendance had initiated or were in the process of developing animal gene banks.

During the past decade, gene banks for AnGR have been initiated on a national level in all geographic regions. In several regions, the gene banking process is quite well developed with substantial numbers of breeds or populations being conserved. This action represents a relatively new approach for the conservation of AnGR and as a result, in some instances, the infrastructure, policies and legal aspects are still evolving on a within-country basis. An important aspect in the development of animal gene banks is that they are country-driven processes and there has been little to no involvement from the international centres of the Consultative Group on International Agricultural Research (CGIAR), particularly in comparison with plants.

For both plants and animals, samples are acquired from targeted populations, stored for unspecified periods of time, and can be requested and used by industry or the research community. However, across the livestock sector policies and best practices are still being developed and implemented. These activities are nationally focused and no extensive dialogue has been initiated about the types of policies and practices necessary for multinational exchange. Therefore, the objective of this paper is to highlight the policy issues of importance for gene banking of AnGR on national and multinational levels, discuss the existing national and international agreements, legislation and regulations that may be relevant for cryoconservation of AnGR and present options for countries considering to establish AnGR cryoconservation programmes.

Gene banks for AnGR

To provide a basis for discussing the types of policies and regulations that might be needed for gene bank operation, the following discussion provides an overview of how gene banks can be used and how they might access material for collection development. There is a general consensus that gene bank collections have multiple functions that include:

- a source of genetic variability for reintroduction into the *in vivo* populations when needed;
- the ability to reconstitute entire breeds or populations as needed, particularly following catastrophic events such as disease epidemics or civil strife;
- development of new breeds or research populations; and
- a source of DNA for molecular studies.

As a result of these benefits, a number of national gene banks have already accumulated significant stores of germplasm that cover a wide range of species, breeds and special populations (Danchin-Burge and Hiemstra, 2003; Blackburn, 2009). As an example, the United States has developed, to date, a germplasm collection that contains 560 000 samples from 12 500 animals and has increased annually by approximately 50 700 samples per year since inception (www.ars.usda.gov/Main/docs.htm?docid=16979). In addition, this gene bank has had samples from over 2 000 animals exit the repository to (1) add genetic variability to *in situ* populations, (2) reconstitute populations that had been discontinued and (3) be used in genomic studies.

Collection development

The physical acquisition of germplasm for national collections can be accomplished in a number of different ways. For example, samples can be obtained from public or private artificial insemination (AI) collection centres or on farms, or in the case of epididymal sperm or ovaries

collection can occur in slaughterhouses and meat packing plants. Determining where samples are collected will depend on the costs of collection activities and the type of genetic resources that are available for collection via these approaches. When conducting field collections it may be feasible to make arrangements with livestock producers to transport their animals to an AI centre or a common meeting area where the animals can be collected and the germplasm can be either frozen in the field or shipped to a laboratory for processing.

Although gene bank managers must be flexible in the approaches used to execute collections, any approach taken warrants a degree of caution. Whether collections occur within an AI stud or in the field, there are several technical concerns. The first issue regards collection of semen. The ability to obtain viable samples from any male is always a concern, but it is particularly important if males have been inactive. Therefore, it is desirable, whenever possible, to collect males more than once. A second issue is, to the extent possible, to determine that the animal being sampled is free of any sexually transmitted diseases for which the pathogen may be present in the semen or attached to an embryo or oocyte. Many potential diseases can be tested for using blood samples or the germplasm itself and some disease evaluations can be performed after the animal is collected. Then the final decision on whether the sample should be kept for breeding purposes can be made based on the results of these tests. Although such collection approaches may not meet the official international export standards (which will be discussed later in this paper), managers of the national gene bank may find such tests to be necessary to ensure that no transmission of diseases within the country can occur.

In collection development, a number of experiences have illustrated the importance of maintaining a high degree of flexibility in terms of actual collection strategies. Such flexibility is needed because different species and breeds within species can be produced in varying production systems and in different geographic locations. In addition to being flexible in technical terms, varying animal ownership patterns may require different approaches or agreements (these will be discussed in the next section).

Laws and regulations of relevance for gene banking of AnGR

Private property

Across nations the most prevalent law concerning livestock and AnGR are private property laws. Without exception nations consider livestock as private property and therefore the owner of the animal also owns the genetics of a particular animal (NRC, 1993b; Neeteson, 2010). In addition to national laws, protection is prescribed in the UN Universal Declaration of Human Rights, Article 17 and in the European Convention on Human Rights, Protocol 1.

On a general level, the relationship between property rights as a social compact between constitutions and legislators and the natural rights of man has been made over time (e.g. VanHorne's Lessee vs Dorrance, 2 U.S. 304 (1795) 2 U.S. 304 Dallas; http://laws.findlaw.com/us/2/304.html). The roots for the association of private property rights and protection under law date back to the early works of Adam Smith, who stressed that the expectation of profit from improving one's stock of capital rests on private property rights. Therefore, it is a central assumption of capitalism that property rights encourage the owner to develop the property, generate wealth and efficiently allocate resources based on the operational markets; this point has generally been argued to apply to AnGR (Blackburn, 2007).

In addition to property laws, the next most common set of laws impacting livestock producers deals with production and marketing, some of which have the potential to affect gene banking directly or indirectly for the conservation of AnGR. Many of these regulations were summarized in a review by Food and Agriculture Organization of the United Nations (FAO) of the policy framework regarding AnGR (FAO, 2005). These regulations vary widely in their target and scope. For example, they range from national to international and from "soft law" to legally binding instruments. Regulations may also have positive or negative influences on the management of AnGR and operation of gene banks for their conservation.

National legislation and regulations

In addition to the legal review (FAO, 2005), in recent years FAO has undertaken two surveys from which information regarding the existence of national regulations on national or multinational gene banks was collected. In both cases, such policies and regulations were not the main focus of the survey, but were collected along with more general information on AnGR and gene banking.

In the first instance, information on policies and legislation regarding national management of AnGR was collected as part of the process undertaken to prepare Country Reports for the SoW-AnGR (FAO, 2007a). A more recent survey on AnGR conservation activities (Boettcher and Akin, 2010) included a single question on national policies and regulations that could affect the participation of a given country in multinational gene banks.

General animal and animal breeding legislation

In the information collected, no country noted specific legislation on cryoconservation of AnGR; however, as previously mentioned these areas fall under the protection ensured through laws concerning private property.

Nevertheless, a number of countries have in place either general agricultural or livestock policy that could have indirect effects on cryoconservation of AnGR or specific policy on the management of AnGR (FAO, 2007b), whereas others have policies dealing directly with AnGR conservation in general. In both these cases, the policies address *in vivo*, particularly *in situ*, more directly than *in vitro* conservation. For example, a number of countries, including the United States, Norway, Pakistan, Botswana and Mali, have laws regarding access to grazing lands and water, supporting the pastoralist farming system and indirectly the maintenance of their livestock populations. Other countries, such as Poland and Mexico, have legislation regarding farmers' and breeders' organizations. Such legislation could indirectly impact *in vitro* conservation when the gene bank is operated by such organizations. Other countries, particularly in Europe and the Caucasus region, reported having regulations and policies related to the use of reproductive biotechnologies such as artificial insemination and embryo transfer (FAO, 2007b). Although these policies were generally developed with a focus on genetic improvement and *in situ* production, these technologies are fundamental in the establishment of gene banks and the eventual use of the stored genetic material.

Other policies have been designed to foster and support trade in local animal products. These policies can take a number of forms. Some, such as the "White Revolution" Programme in Mongolia, supported the production and consumption of local livestock products (Ser-Od and Dugdill, 2006). Others support the exportation of local products or impede the importation of animal products from other countries. Where these policies clearly do not directly address conservation of local AnGR, especially cryoconservation, they do assist in the generation of income from local AnGR, increasing the financial resources available for AnGR management, a portion of which could eventually be directed at conservation.

Animal health and disease

The primary objective of establishing a gene bank is to collect and preserve a significant proportion of the genetic variability that exists in a livestock population of interest. In many countries, especially those without extensive pedigree recording, sampling of animals in the field, across a wide geographical range, will help ensure greater variability. Such a process may also increase the possibility of sampling animals with a range of pathogens. In addition, animals may be transported to a central facility for germplasm collection, which also has the potential for spreading disease.

Although AI is generally considered to be superior to natural mating with regard to animal health, various livestock diseases can be transmitted through cryopreserved germplasm (e.g. OIE, 1986; Givens *et al.*, 2003; Kirkland *et al.*, 2009). In addition, pathogens may be able to survive in the liquid nitrogen used to freeze and store preserved germplasm (Grout and Morris, 2009). That said, no evidence exists of pathogens that were present in a liquid nitrogen tank contaminating the germplasm within the storage vessel. For these reasons, many countries have animal health policies that address the collection and cryopreservation of germplasm from those animals.

Collection of germplasm for gene banking may involve the movement of donors to a collection centre. Transport of animals can facilitate the transfer of disease and therefore many require regulation. Clearly, transport creates the opportunity for movement of a pathogen from an infected area to one that had previously been free from a pathogen. In addition, transport may often involve the mixing of animals from different farms, increasing the possibility of farm-to-farm disease transmission. Movement of animals is also a stressful activity, which may weaken their immune systems, leaving them more prone to contract disease. Transport of animals also involves issues regarding animal welfare; in addition to animal health, some regulations may exist that address this aspect. All these types of regulations may be relevant for national or multinational gene banks and are particularly important when animals are transported across national borders.

In certain countries with federal governments such as the United States and Canada, states or provinces may have their own regulations on transport of animals within and across their borders. In addition, Canada has regulations prohibiting the off-farm transfer and use of germplasm that has not been collected in a certified AI collection centre (Canadian Food Inspection Agency, 2010).

Another factor that must be considered is that national animal health and general sanitary regulations change over time, for instance, as new diseases and threats emerge and as technology improves the ability to detect and control pathogens can change. If cryopreserved germplasm is shipped out of a given country, to be banked for many years in another country, changes in health and sanitary regulations in the original donor country over the duration of the storage period may effectively prevent or provide an obstacle to its eventual re-entry.

Biodiversity, the environment and access to AnGR

Some countries have enacted legislation or adopted policies on biodiversity or access to AnGR that may be relevant with respect to national and international gene banks (e.g. ELBARN, 2009). For example, in South Africa, the Livestock Improvement Acts of 1977 and 1998 (Republic of South Africa, 2002) dictate that a biological impact study must be undertaken prior to the importation of exotic livestock germplasm. The results of the study must demonstrate that the impact of the importation would be positive. Similar regulations in Algeria allow the government to prohibit importation of exotic germplasm that may be detrimental to local breeds or that are not adapted to local conditions (FAO, 2007b).

These regulations are generally directed towards immediate commercial use and as a result it may be possible to obtain a waiver to such regulations to import germplasm needed for storage in a gene bank (Boettcher *et al.*, 2005).

Other countries have developed legislation with regard to provisions of the Convention of Biological Diversity (CBD) that deal with obtaining prior informed consent from the government before exportation of native AnGR. One motivation for such measures is to protect against biopiracy. For example, issues regarding export of AnGR are addressed in the recently established "Stock Breeding Law of the People's Republic of China" (http://faolex.fao.org/docs/texts/chn61879.doc). The law directs provincial governments to establish a "protection list" of AnGR with particular significance. Any export of genetic material from these breeds, or even cooperation within China with a foreign entity, is subject to special conditions and procedures. These conditions include the necessity to obtain permission from the provincial and state governments, along with the development of a use and access agreement. Exported AnGR are also subject to a quarantine period. "Newly found" AnGR must be characterized by national authorities before they can be exported or be subject to research with a foreign collaborator. The law also has provisions dealing with the importation of AnGR, requiring that an import application is filed with the provincial government for approval and that special measures, including quarantine, are taken if the imported AnGR may be harmful to the local AnGR or environment. The law also calls for the creation and updating of "gene databanks" to further protect AnGR.

In general, it is unlikely that existing national legislation would prevent governments from participating in multicountry AnGR gene banking activities, because any such legislation could be changed or waived by the government, if necessary. However, such legislation could prevent individuals or other non-government entities from depositing local AnGR in gene banks based in other countries.

Survey of national regulations with implications on gene banking of AnGR

As previously stated, the most prevalent national laws concerning the exchange of genetic resources are those involving private property. However, countries might have additional laws that are relevant or specifically tailored to the exchange of AnGR. To answer this question, a survey (Boettcher and Akin, 2010) of national and multinational gene banking activities that included one question regarding the existence of relevant national regulations was performed. Specifically, the survey asked whether respondents were aware of (1) national legislation regarding exchange of genetic material, (2) regulations regarding animal health and welfare, (3) individual contracts between the gene bank operators and providers of genetic material, and (4) other relevant legislation or regulations.

The survey had 169 respondents from 92 countries. For the purpose of this analysis, one pooled response per country was used and the indication by any single respondent of the presence of a given regulation was considered sufficient to conclude that such a regulation exists. For example, if two persons responded from a given country and only one of them said that the country had relevant regulations on animal health, such regulations were assumed to be present.

Figure 1 shows the proportions of countries with the various types of regulations. Approximately 25 percent (N = 23) of the countries had no regulations that would be relevant for participation in multinational gene banking activities, according to the respondents. Only six of these countries reported having national activities for cryoconservation of AnGR. Among the countries with some regulations, 59 percent had within-country cryoconservation activities, which probably indicates a relationship between having cryoconservation activities and awareness of the importance of regulations on germplasm exchange. The largest proportion (71 percent) of the countries reportedly had regulations on animal health and welfare that are important for cross-border exchange of genetic material. Approximately 40 percent of the countries had legislation regarding genetic resources. Finally, about 20 percent of the countries required a material transfer agreement between the owner of the germplasm and the gene bank.

International regulations and agreements

Genetic resources

With regard to international regulations and agreements, the most relevant instrument is the Interlaken Declaration and Global Plan of Action for Animal Genetic Resources (GPA-AnGR; FAO, 2007b). This agreement was adopted by 109 countries at the International Technical Conference on Animal Genetic Resources in Interlaken, Switzerland. The Interlaken Declaration recognizes the important role of private ownership in the management

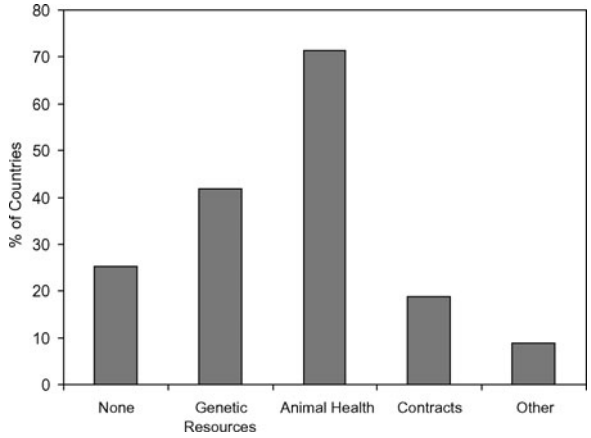

Figure 1. Proportions of countries that have various types of legislation that may be relevant for regional gene banking of animal genetics resources.

and conservation of AnGR (para 12) and thereby the necessity for animal owner concurrence in the collection of germplasm for gene banking purposes. The Global Plan of Action is a rolling plan aimed at decreasing the loss of genetic variability of AnGR and increasing their sustainable use. The GPA-AnGR has 23 strategic priorities (SP) grouped into four strategic priority areas (SPA). One of these four SPA is Conservation of AnGR. The SPA 9 is to "Establish or strengthen *ex situ* conservation programmes" and includes an action regarding modalities to facilitate the use of stored genetic material in a fair and equitable way. The SPA 10 is to "Develop and implement regional and global long-term conservation strategies" and actions include the establishment of regional networks of gene banks of AnGR and harmonization of approaches to facilitate their exchange. The SPA 4 on policies, institutions and capacity-building includes SP 20 and 21, which address the review and development of policies and legal frameworks for AnGR on national and international levels, respectively. However, the GPA-AnGR is not a legally binding agreement.

The CBD is another international instrument with possible ramifications on gene banking activities. With possible regard to national gene banks, the CBD stipulates that nations have the duty to conserve their own genetic resources, which include AnGR. In terms of relevance to international gene banking, the CBD also indicates that access to and exchange of genetic resources among countries should be done on mutually agreed terms and subject to the prior informed consent of the provider of the genetic resources. The CBD is in the process of negotiating an international regime on access and benefit sharing. Such a regime could have negative ramifications on exchange of AnGR, including regional gene banking efforts. The Commission on Genetic Resources for Food and Agriculture is currently working with the CBD to ensure that agricultural genetic resources are recognized as having special qualities that are distinct from other types of genetic resources and will thus require particular access and benefit sharing systems to prevent circumstances that could impede conservation efforts.

In addition to global instruments, some regions of the world have legislation regarding AnGR that may be relevant for cryobanking. The European Union, for example, has been particularly active in developing AnGR-related legislation. For example, EC Regulation 870/2004 established a programme that has supported coordination and exchange of information among member states with the objective of increasing conservation and sustainable use of agricultural genetic resources.

Animal health

The World Organization for Animal Health (OIE) is the main body responsible for setting animal health standards for the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures with respect to international trade. The goal of these activities is to have standards that help prevent the transboundary spread of livestock diseases while preventing countries from using such standards unfairly to block trade. The set of standards that may be relevant for multinational gene banking projects is the Terrestrial Animal Health Code (TAHC) (www.oie.int/eng/normes/mcode/en_sommaire.htm). The TAHC outlines the measures that should be taken by exporting and importing countries to ensure that exchange of animals and animal products (including germplasm) does not result in the transmission of disease. The TAHC has chapters dealing with semen collection, collection and processing of embryos, somatic cell nuclear transfer, import and export of animals, and welfare of animals during transport, all of which may be of relevance to gene banking. For example, the chapter on semen collection and processing has standards for pre-quarantine and the health of the animal prior to collection, diseases for which donor animals should be tested, and conditions and procedures for the collection, handling and processing of semen. Strict adherence to the TAHC would likely preclude the inclusion of genetic material such as semen or oocytes collected in abattoirs or field conditions in multi-country gene banks.

Eventually, it is the responsibility of the countries involved to ensure that the standards are applied. Therefore, the OIE standards will generally be covered by national animal health and sanitary regulations. Most regulations come into play only when animals or animal germplasm cross territorial borders. For example, the Russian Federation has a law, Veterinary and Sanitary Requirements 13-8-01 (FAO, 2007b), regarding the importation of boar semen. This law addresses the sanitary conditions of the semen collection station, the length of quarantine periods, the conditions of feeding and housing, vaccination protocols, semen collection methods and shipping conditions, and requires pathogen- and toxin-free status of the semen. Certified documentation confirming that these various requirements are met must be written in Russian and the language of the exporting country, be signed by the national veterinary inspector and accompany the semen during importation. Most countries have similar regulations for the import of frozen germplasm and require permits regarding animal health and sanitation.

Achieving and maintaining a disease-free status according to OIE is an expensive process, in terms of money, time and effort. Therefore, a gene bank host country with a disease-free status may be unwilling to accept genetic materials from countries where the disease is present, out of concern about losing their status. The disease-free country could provide germplasm to a host in a country without disease-free status, but there would be little direct motivation to do so, as the disease-free country may be reluctant to withdraw the germplasm in the future. In various forums it has been suggested that regional gene banks among countries of a similar status with regard to OIE standards are likely to be more feasible than a single global

gene bank. However, South Asia, countries have tried to form a regional gene bank for aquatic species and have been unable to do so owing to national health concerns; as a result countries have initiated the development of national gene banks (Amirt Bart, 2010, personal communication). This anecdotal example underscores the difficulty in the transboundary movement of AnGR for gene banking purposes.

Policy and legal framework for gene banking of AnGR

Within country

Livestock are most broadly considered private property (NRC, 1993b); thereby livestock owners have ownership over AnGR of their livestock. Deviating from this general precept are situations involving individual producers and breeders who are producing animals under contract for another breeder. In this situation, appropriate aspects of contract law are in effect, affording each party the agreed-upon levels of protection and financial incentive. The prevalence of private property and contract law in effect throughout the livestock sector are two primary elements that gene bank management will have to take into account at the national and international level as they collect, distribute and exchange germplasm.

As gene banks build collections, they may choose to either have outright ownership to the germplasm in the repository or have working arrangements with individuals, companies or breed associations that maintain the ownership of the germplasm. Ownership of the germplasm can be achieved by soliciting the germplasm as a donation from individual producers, companies or organizations, or if the germplasm is considered to be of particular importance they may choose to purchase the germplasm from the breeder.

How the gene bank decides to acquire germplasm, from an ownership perspective, will govern, in part, the types of agreements necessary when releasing the germplasm for use or if the germplasm is to be stored outside the country.

From the standpoint of repository development within country policies and laws may not be well developed. However, the creation of additional laws or policies may not be needed, especially if existing mechanisms are sufficient to ensure the functioning of the gene bank. From a national perspective, relevant laws may already be in place but are written in a wider scope than AnGR. For example, generally livestock are considered private property, and therefore the access and use of livestock and their germplasm fall under laws dealing with private property rights. National laws dealing with gene banks and genetic resources may also be quite generic. For example, in the United States the national legislation directs the Department of Agriculture to develop programmes dealing with the conservation of genetic resources, including AnGR, and that material in the gene bank should be distributed to requestors at no charge. No further detail concerning the acquisition and distribution of germplasm or tissue was provided. That said, it is also recognized that other laws are in effect, which govern the acquisition and use of germplasm.

As national gene banks proceed in developing collections of genetic resources, the ownership of the germplasm should be clearly established. As Neeteson (2010) points out, animals are not owned by governments but are privately and cooperatively owned. Therefore, for gene banks to acquire germplasm and tissue, they need to develop various types of agreements with the animals' owners. In many instances, it has been the United States experience that animal owners see the utility of gene banking animal germplasm by a national entity and as a result freely contribute samples to the repository. In other instances, owners or their associations may wish to maintain a level of control over the germplasm, and therefore place germplasm samples in the repository but retain ownership or the right to influence how the samples are distributed upon request (Danchin-Burge and Hiemstra, 2003; Blackburn, 2009).

In the development of the gene bank, a policy or set of policies needs to be established concerning how and who can access the samples contained in the collection. In the case of the French, Dutch and United States collections, similar protocols have been developed for requesting and subsequent release of material (Danchin-Burge and Hiemstra, 2003; Blackburn, 2009). For each of these three repositories, there are committees that provide input as to the usefulness and validity of the request. For example, in the United States situation one particular function of a relevant species committee is to ensure that the request cannot be met from other private sector sources, instead of utilizing the limited resources of the repository. Figure 2 presents the process for reviewing and approving requests made on the United States gene bank. Establishment of such a process adds transparency to the process of requesting material for livestock producers and the research community.

In addition to developing policies on germplasm release, gene banks may also choose to develop policies concerning the return of germplasm or tissue samples from persons requesting the material. In instances where material is requested for genomic studies, a policy could be developed that ensures that the results obtained from repository animals are transferred to the repository for entry into its database and that the information is publicly available. Such a policy can help replenish the germplasm requested or assist in better quantifying the genotypes of animals stored in the repository.

Multilateral exchange of banked germplasm

There has been discussion in various forums about countries transferring germplasm, which may or may not

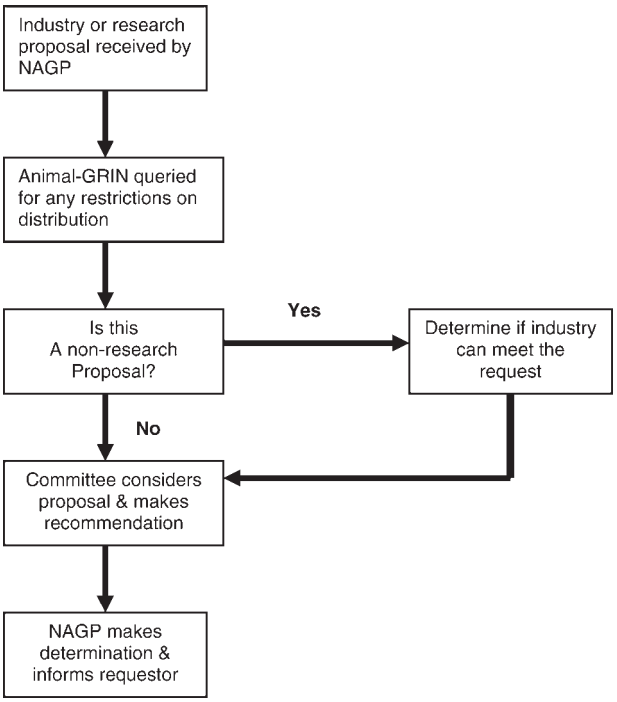

Figure 2. Process for reviewing industry or research requests for animal germplasm or tissue (from Blackburn, 2009).

be a duplicate proportion of their national collections, to other countries or to a yet to be defined regional gene bank. However, at this point in time there are no well-established regional gene banks and their development would be based on the assumption that they would be able to offer significantly better security measures than an individual country. An alternative to a regional approach is development of bilateral germplasm exchange programmes between two countries as a security measure. Having duplicate collections stored outside national boundaries may appear to be a useful mechanism to secure cryopreserved genetic resources, but there are a number of substantial limitations to their implementation, which will become apparent in the following discussion.

As governments consider the question of storing germplasm samples at non-sovereign locations, they should determine if the site for the redundant collection provides improvement in security over other potential storage sites within the country. In doing so, the provider of germplasm should consider if the proposed site has the infrastructure and physical security a country might deem as necessary for considering such a transfer and agreement. As part of this review process, relevant officials may wish to tour the facility where samples are to be stored. In addition to such practical issues, there are a number of administrative details to be considered. Primary among these are the establishment of an agreement between the appropriate government ministry and the regional gene bank entity or the appropriate government ministry that will be storing the samples. Elements for consideration in such an agreement are given in Table 1.

It should be noted that the plant community makes frequent use of what is termed "black box" collections, where the receiving country does not open or have information about the samples being stored in their facility. While this might work, technically, for plants because black box shipments can be placed in their entirety into –18 C storage, for AnGR this approach presents challenges. The long-term storage vessel for AnGR is usually a large liquid nitrogen tank and materials will likely have to be transferred from a shipping container into the storage vessels; during the transfer, breed codes and animal ID will be apparent. These factors complicate the black box approach. As a result, it would not appear that the black box concept has utility for AnGR.

At the national level, gene banks are usually operated by appropriate government agencies. Therefore, the acquisition and release of germplasm is subject to whatever policies and laws the government wishes to develop. It is suggested that if additional laws or regulations are to be formulated, then the robust nature of sample acquisition should be fully considered. For example, Canada's regulations regarding the collection, transfer and use of germplasm from non-certified collection centres (Canadian Food Inspection Agency, 2010) greatly impede or eliminate the possibility of collecting germplasm from rare breeds, which are widely dispersed across the country

Table 1. Potential elements for countries to consider when developing a bilateral agreement for backup storage.

Element of agreement
Agreement type – memorandum of understanding, mechanisms for enforcement
Duration of the agreement and the intended length of the agreement (some countries may only be allowed to establish agreements for a maximum of 5 years, at which time the agreement can be renewed)
Expected storage and handling cost and who is responsible for paying the expenses.
Information accompanying a sample:
– animal ID, breed, type of germplasm, country of origin
– phenotypic information, genotypic information
– number of samples per animal and per breed
Health tests and the results:
– animal ID, tests performed and results
– verification of health status
– if tissue has been collected and stored for future tests
Germplasm viability
– post-thaw viability and quality scores at collection and receipt of materials in the host country and upon repatriation
Availability of any or all data to groups that are either party to or not party to the agreement
Physical conditions for storing samples (e.g. liquid vs vapour phase of liquid nitrogen)
Frequency or extent of monitoring samples by host and country of origin representatives and the reporting process
Mechanisms for repatriating samples to the country of origin (e.g shipping via commercial carrier or government vehicles)

and in all likelihood will never be taken to a certified centre for collection.

Conclusions

Gene banks for conserving AnGR have been established in all major geographic regions. This development has coincided with a growing awareness of the contraction of AnGR on a global basis (FAO, 2007b). As AnGR gene banks have become established, they have had to develop a set of protocols on how to acquire and exchange germplasm samples. As a result, gene bank managers have to be aware of their national laws and policies that set operational boundaries. The most generic law across countries for gene bank managers to deal with is property rights, for it is this set of laws that determines the acquisition and eventual distribution of germplasm stored in a repository. National and international animal health regulations are another major set of laws and regulations that may enter into the acquisition, movement and distribution of genetic resources. Within a country, a portion of the health protocols may take the form as recommendations and not legally binding. Therefore, gene bank managers need to assess their specific situation and determine under what set of conditions certain health protocols will be employed in collection development.

In the area of transferring germplasm across international borders, following health protocols established by OIE may be more critical. However, such a decision will be significantly influenced by the scope of the agreement developed by the two or more countries involved. Based on this agreement and the disease situation in the countries developing the agreement, it may be necessary to comply with OIE and the receiving country's health regulations. However, because the purpose of transferring samples across an international border could be exclusively a backup for national collections, gene bank managers may wish to seek a waiver to any or all health protocols. In addition, it may be desirable to initiate development of OIE protocols for groups of countries wanting to transfer and back up AnGR.

The release of genetic resources from the gene bank need not be only in the case of crisis situations. It is totally feasible for semen, embryos or DNA to exit the repository for routine breeding and research activities. As a result, policies for the release of genetic resources also need to be in place. Concepts guiding the use of the material include ownership of the requested samples. If the gene bank owns the samples, then their technical considerations for release will apply; however, if the gene bank does not hold title to the samples in question, then permission to release the samples will have to be obtained from the owner.

As gene banks have become established, it has become clear that their role can be much larger than a collection of AnGR for use only in emergency situations. As a result, the development of policies for acquisition, release and exchange of genetic resources needs to be established. Because of the diverse mechanisms used to acquire samples and potentially release samples, it becomes evident that gene bank policies need to be flexible enough to ensure that the livestock sector is able to garner maximum benefit from the collection developed by the gene bank.

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A review of the role of protected areas in conserving global domestic animal diversity

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Summary
A content analysis of 167 country reports submitted for the United Nations Food and Agriculture Organization's State of the World's Animal Genetic Resources for Food and Agriculture was conducted to determine the extent to which protected areas are recognized as means of conserving domestic animal diversity. For countries in which protected areas were reported to help conserve the diversity of domesticated animals, additional details were sought from a review of related literature. Protected areas were seldom discussed in country reports and were most often mentioned as means to protect biodiversity in general, wild relatives of domesticated animals or wild game species. The most frequently mentioned way in which protected areas conserve domestic animal diversity is through initiatives that utilize indigenous breeds of livestock in nature conservation programmes. By offering farmers financial incentives for these ecological services, protected areas help offset potential economic disadvantages of raising indigenous breeds that may be less productive in industrial environments. Additional incentives to raise indigenous breeds are supported by protected areas such as niche marketing of organic food and fibre, establishing "seed herd" programmes and tourism promotion. Many opportunities exist for protected area managers and authorities responsible for conserving animal genetic resources for food and agriculture to fulfil mutually compatible objectives.

Keywords: *protected areas, parks, domestic animal diversity, conservation grazing, sustainable development*

Résumé
L'analyse des contenus des 167 rapports nationaux présentés pour la publication de *L'état des ressources zoogénétiques pour l'alimentation et l'agriculture dans le monde* a été effectuée pour définir jusqu'à quel point les zones protégées sont reconnues en tant que moyen permettant de conserver la diversité des animaux domestiques. Pour les pays dans lesquels on a signalé que les zones protégées contribuent à la conservation de la diversité des animaux domestiqués, des détails supplémentaires ont été recherchés grâce à un examen des publications sur ce sujet. Dans les rapports nationaux, les zones protégées ont été rarement abordées et étaient surtout mentionnées en tant que moyens de protection de la biodiversité en général, des races sauvages apparentées aux animaux domestiqués et/ou des espèces de gibier sauvage. La façon la plus mentionnée de conservation de la diversité des animaux domestiques par le biais des zones protégées est représentée par les initiatives qui utilisent les races indigènes d'animaux d'élevage dans les programmes de conservation de la nature. Grâce aux incitations financières offertes aux agriculteurs pour ces services écologiques, les zones protégées contribuent à compenser les inconvénients économiques potentiels relatifs à l'élevage des races indigènes qui pourraient être moins productives dans les environnements industriels. D'autres mesures d'incitation pour l'élevage de races indigènes sont soutenues par les zones protégées, comme le créneau commercial spécialisé d'aliments et de fibres biologiques, la mise en place de programmes de «troupeau fondateur» et la promotion du tourisme. De nombreuses possibilités sont ouvertes aux préposés des zones protégées et aux autorités qui sont responsables de la conservation des ressources zoogénétiques pour l'alimentation et l'agriculture pour la réalisation d'objectifs réciproquement compatibles.

Mots-clés: *zones protégées, parcs, diversité des animaux domestiques, pâturage de conservation, développement durable*

Resumen
Se llevó a cabo un análisis del contenido de los 167 informes nacionales presentados para la elaboración de La situación de los recursos zoogenéticos mundiales para la alimentación y la agricultura de la FAO, con el fin de determinar en qué grado las áreas protegidas son reconocidas como medio para la conservación de la diversidad de animales domésticos. En aquellos países en los que se informó de las áreas protegidas como medida para la conservación de la diversidad de animales domesticados, se trató de encontrar detalles a partir de la literatura relacionada. Las áreas protegidas se trataron rara vez en los informes nacionales y, a menudo, fueron mencionadas como medio para proteger la biodiversidad en general, los parientes silvestres de los animales domésticos, y / o especies de caza silvestre. La forma mencionada más frecuentemente en que las áreas protegidas conservan la diversidad de los animales domésticos es a través de las iniciativas que utilizan a las razas autóctonas de ganado en los programas para la conservación de la naturaleza. Ofreciendo a los agricultores incentivos económicos por estos servicios ecológicos, las áreas protegidas contribuyen a compensar posibles desventajas económicas relacionadas con la cría de razas autóctonas que puedan ser menos productivas en ambientes industriales. La dedicación a la cría de razas locales es apoyada por áreas protegidas tales como nichos de mercado de alimentos ecológicos y

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fibra, estableciendo programas de "grupos de semillas" y la promoción del turismo. Existen muchas oportunidades para los gestores de las áreas protegidas y las autoridades responsables de la conservación de los recursos zoogenéticos para la alimentación y la agricultura para cumplir los objetivos compatibles entre sí.

Palabras clave: *Áreas protegidas, parques, diversidad de los animales domésticos*

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Introduction

The United Nations Food and Agriculture Organization (FAO) reports that 690 (9 percent) of the world's 7 599 documented breeds of livestock have become extinct within the past 150 years (Rischkowsky and Pilling, 2007). Furthermore, 1 487 (20 percent) additional breeds are now at risk of extinction, and the status of 2 732 (36 percent) of the remaining livestock breeds is unknown.

Means to conserve animal genetic resources (AnGR) for food and agriculture (AnGR) include: (1) *in vitro* methods, i.e. cryopreservation of reproductive material or other tissue samples and (2) *in vivo* methods, i.e. maintaining live populations either *in situ* (within the landscapes in which they were developed) or *ex situ* (outside of their original landscapes, e.g. in zoological parks). Geerlings, Mathias and Köhler-Rollefson (2002) advocate *in situ* conservation of live populations as the most realistic way to conserve locally adapted breeds of livestock, particularly if the production systems in which the breeds evolved can also be maintained. Köhler-Rollefson (2000) explains: "[I]ndigenous breeds are products of specific ecological and cultural environments, and their genetic make-up and integrity will be affected if they are removed from their original contexts. Transfer of domestic animal populations into the controlled environments of government farms poses the danger of a gradual erosion of their adaptive traits" (p. 1).

Where protected areas overlap with landscapes created and utilized by people engaged in traditional agricultural or pastoral practices, a potential exists for protected areas to contribute to the *in situ* conservation of domestic animal diversity. In comparison with the role of protected areas in conserving plant genetic resources of interest for food and medicine (Prescott-Allen and Prescott-Allen, 1983; Guzmán and Iltis, 1991; Nabhan and Tuxill, 2001; Phillips, 2002; Argumedo, 2008; Bassols Isamat *et al.*, 2008; Nozawa *et al.*, 2008; Sarmiento, 2008), the contribution of protected areas to conserving domesticated animal genetic resources has received relatively little attention until recently (Henson, 1992; Woelders *et al.*, 2006; Bassi and Tache, 2008; Cole and Phillips, 2008; Ivanov, 2008; Pokorny, 2008; Rosenthal, 2008).

The purpose of this study is to determine the extent to which national bodies reporting on the state of their country's animal genetic resources recognize protected areas as means of conserving domestic animal diversity. To accomplish this aim, a content analysis of country reports submitted for the FAO's State of the World's Animal Genetic Resources for Food and Agriculture report was conducted. Where protected areas were reported in the country reports as means to conserve domestic animal diversity, a wider review of academic literature and scholarly reports was conducted to characterize this role. Specific examples of protected areas and the roles they play in the conservation of some indigenous or at-risk breeds are highlighted, as are the ecological and socio-economic contributions of the breeds to protected area management.

Methods

In 2001, the FAO invited 188 countries to participate in the preparation of the first State of the World's Animal Genetic Resources report by preparing an assessment of their national animal genetic resources by the end of 2005. Guidelines and training were provided by the FAO to standardize the content of each country's report. The objectives of the country reports were: "a) to analyze 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; b) to assess the state of the country's capacity to manage these essential resources, in order to determine priorities for future capacity building; and c) to identify the national priorities for action in the field of sustainable conservation and utilization of AnGR and related requirements for international co-operation" (FAO, 2001, p. 8). Information on the role of protected areas in conserving domestic animal diversity was not explicitly solicited in the FAO guidelines (FAO, 2001).

In January 2008, reports from 169 countries were available online from FAO's Domestic Animal Diversity Information System (DAD-IS) (FAO, 2008). Of those reports, 119 were available in English, 28 in French and 20 in Spanish. Some reports were submitted in English or French, as well as in an additional language. One report was submitted only in Italian and another only in Portuguese. Because of the author's unfamiliarity with these latter two languages, these reports were excluded from the analysis. Thus, the 167 reports in English, French or Spanish were analysed for terms relating to parks and protected areas using the search functions of Adobe Reader version 8.1.0 and Preview version 3.0.8. The search terms used include: in English: Natur*, *Reserv*,

Protect*, Park; in French: Natur*, *Réserv*, Prot*, Parc, Aire; or in Spanish: Natur*, *Reserv*, Prote*, Parque. Asterisks indicate that search terms were structured to allow for variations, mainly in suffixes, of relevant words (e.g. searching for "reserv" could return terms such as reserve, preserve, preservation area). The term "conservation" and its equivalent in French and Spanish were not used in the searches because of the frequency of their use in the body of the documents in relation to the conservation of animal genetic resources, rather than in the context of environmental conservation. For the purposes of this analysis, a protected area is defined according to the International Union for Conservation of Nature (IUCN) definition as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008, p. 8) and includes nature reserves, national parks, world heritage sites (natural), UNESCO biosphere reserves, etc. Farm parks, i.e. individual farms established to demonstrate breeds or farming practices, are not included in this analysis. In order to verify whether any terms relevant to protected areas were missed, 10 percent of the documents in each language (12 English, 3 French and 2 Spanish) were read from cover to cover.

The country reports that included any of the searched terms were analysed to determine the context in which the term was used. The country reports that mentioned protected areas were then categorized as (1) currently including AnGR within protected areas or (2) advocating the involvement of protected areas in AnGR conservation; and (a) referring to domesticated livestock or (b) referring to wild forms of animal genetic resources.

The results from the analysis of the country reports served as a starting point from which a literature review was conducted for additional information on the ways in which protected areas contributed to the conservation of domestic animal diversity and, conversely, on the ecological and socio-economic benefits offered by the breeds to the protected areas. The analysis was limited to initiatives involving indigenous breeds (i.e. breeds with a long history – at least 100 years – in the country of the protected area), and also considered programmes involving non-indigenous breeds that are at risk of extinction according to the DAD-IS. Scientific publications and scholarly reports were sought for these specific cases where protected areas were reported in the country reports to be involved in the conservation of indigenous or at-risk breeds. This literature review led to the discovery of some documents revealing the use of indigenous breeds in ways or places not mentioned in the country reports; however, literature was not explicitly sought other than to obtain further information about the cases mentioned in the country reports. Except for regarding Benin and Croatia, no attempt was made to directly obtain further information from protected area personnel or national coordinators for animal genetic resources. Individuals aware of examples of the use of indigenous or at-risk breeds in protected areas that were not addressed in this study are encouraged to contact the author to enable the development of a more complete assessment of the global extent of this phenomenon.

Results

Sixty-one (37 percent) of the State of the World's Animal Genetic Resources Country Reports that were analysed mentioned protected areas, at least in relation to conservation of biodiversity in general (Table 1). One-third of these (21 countries) referred to protected areas specifically as means to conserve wild relatives of domesticated animals or wild game species. Sixteen of the country reports (10 percent of the country reports analysed) simply mentioned protected areas as a means to conserve biological diversity in general, but were not clear whether they were referring only to wild animal species or also to domesticated species. Three countries (Peru, Philippines and Swaziland) suggested that the presence of domesticated animals served as tourism attractions in protected areas. Two reports (Chad, Burkina Faso) simply indicated that livestock existed in protected areas.

Only 15 reports (9 percent of all the country reports analysed) revealed that the use of some forms of domestic animal diversity was actively encouraged through programmes involving protected areas. Two countries (Japan and the Republic of Korea) designated some at-risk breeds, themselves, as natural monuments, which afforded the animals and their habitats protection. Benin reported that one nature park was involved in the conservation and development of the Somba cattle,[1] an indigenous breed, though no further details about the nature of the conservation activities were provided nor could be obtained from the Benin AnGR national coordinator. Poland reported that the indigenous Konik horse (*Equus ferus f. caballus*) is maintained in forest reserves. In Ecuador, the husbandry of domestic camelids is encouraged both in and around Cotopaxi National Park. The Nepal country report indicated that the nearly extinct Bampudke pig is found in and around the Chitwan and Bardia National Parks, and called for the creation of a breed conservation plan to be developed in partnership with the protected area authority. In France, Parc Interregional du Marais Poitevin provides assistance to breeders of seven breeds of at-risk livestock. Furthermore, the French report stated that the French Federation of Regional Natural Parks also initiated a network of stakeholders to exchange knowledge and encourage collaboration for maintaining protected areas through extensive grazing, particularly with indigenous breeds. Eight countries (Belgium, Croatia, Germany, Hungary, Ireland, The Netherlands, Sweden and the United Kingdom) stated that the conservation of domestic animal diversity was

[1] Unless otherwise noted, all cattle in this study are *Bos taurus*, sheep *Ovis aries*, pigs *Sus domesticus*, horses/ponies *Equus caballus*, asses *Equus asinus*, goats *Capra aegagrus hircus*, chickens *Gallus domesticus* and geese *Anser anser*.

Table 1. Contexts in which parks and protected areas were mentioned in country reports.

Country	General biodiversity	Wild animals	Domestic animals	Bees	Identified potential[1]	Nature conservation
Algeria	x				x	
Australia			x (feral)			
Barbados		x				
Belarus		x				
Belgium			x			x
Benin			x			
Bhutan	x					
Bolivia		x				
Burkina Faso			x			
Cameroon	x				x	
Canada		x				
Chad	x		x		x	
Chile	x					
China	x			x		
Columbia	x					
Croatia			x			
Cyprus		x				
Denmark			x		x	x
Djibouti	x					
Ecuador			x			
El Salvador				x		x
Equatorial Guinea		x				
France			x			x
Gabon		x				
Germany			x			x
Ghana		x				
Greece	x					
Guinea Bissau	x				x	
Haiti	x					
Hungary			x			x
Ireland			x			x
Japan			x			
Kenya		x				
Malawi		x				
Malaysia	x				x	
Mexico	x					
Nepal			x			
The Netherlands			x			x
Nigeria	x	x				
Pakistan		x				
Paraguay		x				
Peru		x				
Philippines			x			
Poland			x	x		x
Republic of Korea			x			
Romania			x		x	x
Saint Kitts & Nevis		x				
Sao Tome e Principe		x				
Serbia & Montenegro			x		x	x
Sierra Leone		x				
South Africa			x			
Spain			x		x	
Sri Lanka		x	x (feral)			
Suriname		x				
Swaziland			x			
Sweden			x			x
Tajikistan		x and "½ wild"			x	
Tanzania			x		x	
United Kingdom		x	x			x
Uruguay	x					
Venezuela	x					

[1]The column "Identified potential" indicates that the potential for protected areas to contribute to the conservation of AnGR was identified in the country report, but no indication was given that any initiatives were actually underway.

encouraged by protected area managers through the use of these animals as tools for ecological management (e.g. to maintain disturbance-dependent habitats, to control invasive vegetation, to create habitat for wildlife or to promote biodiversity). Information that was available on the specific breeds and protected areas involved in these active conservation programmes has been summarized in Table 2 and is based on the content analysis of the country reports as well as supplementary information gathered from the wider review of literature related to the case highlighted in the country reports.

An additional three reports (Denmark, Romania, and Serbia and Montenegro) recognized that domestic animals could provide such ecological services in protected areas and recommended that domestic animals, especially older breeds, be encouraged to assist with nature conservation efforts. The Romanian country report indicated that domesticated animals are permitted in the Economic Zone of the Danube Delta Biosphere Reserve/World Heritage Site, but they are not allowed in national protected areas. The Romanian country report stressed the need for protected area authorities to acknowledge that indigenous domestic animals can be important components of natural landscapes where they could be conserved while contributing to nature protection initiatives. Similarly, the Tanzanian country report identified the exclusion of indigenous breeds of livestock from protected areas and game reserves as a constraint to the conservation of domestic animal diversity.

With regard to domestic animal diversity, protected areas received relatively little attention within the country reports submitted for the FAO's State of the World's Animal Genetic Resources reporting. Where protected areas were mentioned at all, rarely was more than a paragraph or two devoted to describing the nature of the involvement of protected areas in the conservation of domestic animal diversity. The wider search for literature to obtain additional details about these initiatives revealed that there are more cases in which protected areas are engaged in the conservation of domestic animal diversity than were acknowledged in the country reports. Indeed, some countries in which indigenous or at-risk breeds are utilized in conservation programmes within protected areas (e.g. Austria, see Schermer, 2004), failed to identify such initiatives within their descriptions of the current mechanisms in place in their nation to conserve animal genetic resources for food and agriculture. Other countries (e.g. France and Ecuador) mentioned one or two protected areas involved in conserving domestic animal diversity, but overlooked important initiatives in other protected areas within their nation. Furthermore, when a protected area was identified as being involved in the conservation of indigenous breeds of livestock, the number of breeds conserved was under-reported at least in one circumstance (i.e. in the Ireland country report, only one indigenous breed was identified as being conserved in Killarney National Park, even though three critically endangered indigenous breeds are also raised there according to the Killarney National Park management plan; National Parks and Wildlife Service, 2005). In addition, new initiatives to conserve indigenous breeds of livestock within protected areas commenced after countries submitted their country reports to the FAO (e.g. Finland, see Lovén and Äänismaa, 2006).

Discussion

The results of the content analysis of country reports and associated literature review reveal an under-representation of the extent of involvement of protected areas in the global conservation of domestic animal diversity. This fact may encourage those involved in developing national reports and strategies for the conservation of animal genetic resources to give the role of protected areas greater consideration in their future plans and reports. The following discussion reflects the themes that emerged from the extended literature review of cases initially mentioned in the country report and summarizes the main ways in which protected areas are currently contributing to the conservation of global animal genetic resources for food and agriculture.

Wild animal diversity

Because the primary objective of most protected areas is to conserve wild forms of biodiversity, it is not surprising that the context in which most of the reports mentioned protected areas was with regard to the conservation of game species or wild relatives of domesticated animals. The role of protected areas in the conservation of wild species is well established and its description is beyond the scope of this article.

Feral and free-ranging livestock

In some cases, it is difficult to categorize wild versus domesticated forms of animals (Clutton-Brock, 1989), as there are not always clear-cut boundaries between wild animals used in part by humans and free-ranging domesticated animals with little to no management by humans. Vicuñas (*Vicugna vicugna*), for example, are generally considered wild, but are corralled annually in some national parks by local community members to harvest fibre (Wheeler and Hoces, 1997). For the purposes of this study, vicuñas are treated as wild species and so further details of their conservation within protected areas were not sought.

Some country reports (e.g. Australia and Sri Lanka) identified the existence of feral animals within protected areas. In Australia feral Brumby horses and in Sri Lanka feral buffalo (*Bubalus bubalus*) are considered threats to natural features conserved within the protected areas, including endangered wild species. Management actions undertaken by several Australian protected areas aimed to reduce, if not eliminate, feral Brumby populations (Norris and Low, 2005). If populations of feral animals must be

Table 2. Specific protected areas in which indigenous or at-risk breeds are reported in the literature reviewed.

Country	Park	IUCN protected area category	Breed	Status	Source
Belgium	Hautes – Fagnes – Eifel	V	Red Ardennes Sheep	END	Delescaille (2002)
	De Houtsaegerduinen Nature Reserve	–	Konik horse	END-M[1]	Cosyns *et al.* (2001)
Croatia	Lonjsko Polje Natural Park	V	Slavonia-Syrmian Podolia cattle	CR-M	Gugic (2008)
			Turopolje hogs	END	
	Nature Park Kopacki rit	V	Slavonia-Syrmian Podolia cattle	CR-M	Jeremic (2008)
			Posavac horse &	NAR	
			Black Slavonian pigs	END-M	
Ecuador	Cotopaxi National Park &	II	Llamas &	NAR	Ecuador Country Report
	Chimborazo Faunal Production Reserve	VI	Alpacas	NAR	Rosenthal (2008)
France	Volcans d'Auvergne	V	Farrandaise cattle	END-M	Audiot (1983)
	Cévennes	V	Raïole sheep	NAR	Audiot (1983)
	Landes de Gascogne	V	Landais sheep	END-M	Audiot (1983)
	Marais Poitevin	IV	Poitou ass,	END	Audiot (1983) and France Country Report
			Poitevin horse,	END-M	
			Maraîchine cattle,	END	
			Poitou goat,	NAR	
			Blanche du Poitou goose,	END	
			Gris du Marais Poitevin goose	–	
			Marans chicken	NAR	
	Luberon	V	Rove goat	NAR[2]	Audiot (1983)
	Armorique	V	Bretonne Pie-Noir cattle &	END	Audiot (1995)
			Monts d'Arrée (Ouessant) sheep	NAR	Lauvergne (1980)
	Grands Causses	V	Raïole sheep	NAR	Audiot (1995)
			Rouge du Roussillon sheep &	NAR[3]	
			Caussenard des Garrigues sheep	NAR	
	Camargue	V	Camargue horse	END	Audiot (1995)
	Caps de Marais d'Opale	V	Boulonnais sheep	NAR[4]	Audiot (1995)
			Boulonnais horse	END-M	
	Corse	V	Corsican horse	EXT	Audiot (1995)
	Morvan	V	Nivernais horse	EXT	Audiot (1995)
	Marais de Bruges	IV	Casta cattle	END-M	Audiot (1995)
			Landais poney	CR	
	Tour du Valat	IV	Casta cattle	END-M	Audiot (1995)
	Chérine	IV			
	Marais de Lavours	IV	Camargue horse &	END	Audiot (1995)
			Pottok poney	END-M	
Germany	Rhön Biosphere Reserve	V and IV	Rhön sheep	NAR[5]	Pokorny (2008)
	Solling-Vogler Nature Park	V	Exmoor ponies &	END[6]	Gerken and Sonnenburg (2002)
			Heck cattle	END[6]	
Hungary	Hortobágy National Park	II	Hungarian grey cattle	NAR	Megyesi and Kovách (2006)
			Racka sheep &	NAR[7]	
			Mangalica pigs	END-M	
Ireland	Killarney National Park	II	Kerry cattle	NAR[8]	Harrington (2002)
			Droimeann (Drimmon) cattle,	CR	National Parks and Wildlife Service (2005)
			Maol cattle &	CR	
			Dexter cattle	CR	
Japan	Breeding area of Misaki horse	–	Misaki horse	CR-M	Japan Country Report
	Place of Origin of Mishima cattle	–	Mishima cattle	CR	Japan Country Report

Continued

Table 2. Continued

Country	Park	IUCN protected area category	Breed	Status	Source
Nepal	(Royal) Chitwan National Park	II/IV	Bampudke pig	UNK	Nepal Country Report and Gautam *et al.* (2008)
	(Royal) Bardia National Park	II/IV			
Netherlands	Oostvaardersplassen &	III/IV	Heck cattle &	END	Vulink and Van Eerden (1998)
	Veluwezoom National Park	II/IV	Konik horse	UNK	Piek (1998)
Poland	Biebrza National Park	–	Konik/ Tarpan horses	END-M	Borkowski (2002)
	Roztocze National Park	II	Konik horse	END-M	Sasimowski and Slomiany (1986)
Romania	Danube Delta Biosphere Reserve	II	Sura the Stepa cattle &	END-M	Meissner (2006)
			Romanian buffalo	NAR	
United Kingdom	Northumberland National Park	V	Cheviot sheep	NAR	Cole and Phillips (2008)
			Beef Shorthorn cattle	NAR	
	Cotswold Area of Outstanding Natural Beauty (AONB)	V	Cotswold sheep	END-M	Cole and Phillips (2008) and Yarwood and Evans (2000)
	North Wessex Downs AONB	V	Wiltshire horn sheep	NAR	Cole and Phillips (2008)
	Cranborne Chase & West Wiltshire Downs AONB	V			
	Lake District National Park	V	Herdwick sheep	NAR	Cole and Phillips (2008)
	Lincolnshire Wolds AONB	V	Lincoln Red cattle	END	Cole and Phillips (2008)
	Dartmoor National Park	V	Dartmoor pony	END-M	Yarwood and Evans (2000)
	Yorkshire Dales National Park	V	Beef Shorthorn cattle &	NAR	Cole and Phillips (2008)
			Swaledale sheep	NAR	Yarwood and Evans (2000)
	New Forest National Park	V	New Forest ponies	UNK	Spencer (2002)
	Burnham Beeches	–	Exmoor ponies,	END	Spencer (2002)
			White park cattle &	END	
			Berkshire pigs	END	
	Norfolk Coast AONB &	V	Red poll cattle	NAR	Cole and Phillips (2008)
	Suffolk Coast & Heaths AONB	V			
	High Weald AONB	V	Sussex cattle	NAR	Cole and Phillips (2008)
	Sussex Downs AONB	V	Sussex cattle &	NAR	Cole and Phillips (2008)
			Southdown sheep	NAR	
	East Hampshire AONB	V	Southdown sheep	NAR	Cole and Phillips (2008)

IUCN categories: II = National Parks – large natural or near natural areas that protect large-scale ecological processes and species therein; III = Natural Monument or Features – specific natural monuments with high visitor value; IV = Habitat/Species Management Area – areas that protect particular species or habitats; V = Protected Landscapes/Seascapes – area that protects the ecological, biological, cultural and scenic values of areas shaped by the interaction of people and nature over time; VI = Protected Area with Sustainable Use of Natural Resources – natural areas in which a proportion of the land is used for sustainable, non-industrial natural resource management. For more information on these categories see Dudley (2008).
CR: Critical. Total no. of breeding females ≤100 or total no. of breeding males ≤5 or total population size is ≤120 and decreasing and percent of females bred to males of same breed is <80 percent.
CR-M: Critical-Maintained. Critical populations for which active conservation programmes are in place.
END: Endangered. Total no. of breeding females is between 100 and 1 000.
END-M: Endangered-Maintained. Endangered populations for which active conservation programmes are in place.
EXT: Extinct.
NAR: Not at risk.
UNK: Risk status is unknown.
[1]This breed is not included in the list of breeds for Belgium in DAD-IS, but is END-M in Poland.
[2]Was END in 1983 when the conservation programme began.
[3]Was CR in the 1990s.
[4]Was END in 1983.
[5]Fewer than 100 were registered in 1975.
[6]These breeds are not included in the list of breeds for Germany in DAD-IS, but are both END in other countries.
[7]Listed as END-M in Austria and END in Romania.
[8]Listed as CR in the United Kingdom.

removed from protected areas for ecological reasons, consideration should be given to find appropriate venues for the *ex situ* conservation of potentially unique genetic resources in feral populations.

Konik horses and Heck cattle (*Bos primigenius f. taurus*), animals that were derived from domesticated animals with the intention of resurrecting characteristics of extinct wild Tarpan horses (*Equus ferus ferus*) or Auroch (*Bos*

primigenius), respectively, are treated as domesticated animals for the purposes of this study as are free-ranging animals such as Exmoor ponies or Camargue horses that are owned or have some human management regarding breeding, so details of their use in protected areas are included in the following discussion.

Bees

The country reports were intended to focus on mammalian and avian species of interest to food and agriculture; however, some countries also provided commentary on bees (*Apis* spp.). Because of the difficulty in classifying bees as either domesticated or wild life forms, and in light of the widespread decline in bee populations and their importance to food and agriculture as sources of honey and pollination (Nabhan *et al.*, 1998) they are briefly given special consideration here. In particular, China, El Salvador and Poland identified protected areas as important reserves to prevent declines in bee populations. Efforts directed towards the conservation of bees both within and outside of protected areas may be worth further examination and possible inclusion in future State of the World's Animal Genetic Resources for Food and Agriculture reporting.

Grazing for nature conservation

In most of the countries that reported active promotion of domestic animal diversity within protected areas, livestock grazing was integrated as a means of achieving environmental conservation objectives, such as controlling invasive vegetation, maintaining disturbance-dependent habitats, increasing biological diversity, reducing soil erosion and creating habitat for wildlife. Examples of these nature conservation benefits associated with indigenous breeds of livestock grazing within protected areas are described below.

Indigenous and non-indigenous breeds

Although conservation grazing can theoretically be done with most breeds of livestock, some countries (e.g. Belgium, Ireland and Sweden) are beginning to prioritize the use of indigenous or at-risk breeds for this purpose. Because indigenous breeds are reputed to be hardier and better adapted to the local environment and extensive grazing conditions (e.g. Telenged, 1996; Wright *et al.*, 2002), they are believed to be well suited for conservation grazing projects. However, some comparisons between local versus industrial breeds at low grazing intensities (0.63–1.52 livestock units/ha) have not yet revealed any significant differences in the impact of grazing on biodiversity (Rook *et al.*, 2004; Scimone *et al.*, 2007; WallisDeVries *et al.*, 2007). In these studies, however, no comparisons between industrial and traditional indigenous breeds were made at higher stocking rates, nor did these studies account for the role of the place of origin of the breeds in question, the history of the breeds' existence in or around the study sites, or implications of the use of industrial breeds that were the results of crossbreeding with traditional indigenous breeds. Indeed, many more studies are necessary to determine whether indigenous breeds are more or less suitable than other breeds for fulfilling conservation grazing objectives.

Non-indigenous, at-risk Exmoor ponies or Konik horses and Heck cattle (a composite of indigenous and non-indigenous breeds) are used in protected areas in Germany and the Netherlands as surrogates for extinct megaherbivores that once occupied the landscape (Piek, 1998; Bunzel-Drüke, 2001). Whether it is appropriate to use non-indigenous breeds for this purpose is debatable. Although inclusion within protected areas does contribute to the conservation of these at-risk breeds, it may be held that non-indigenous breeds are inappropriate elements to include in protected areas as they convey unauthentic representations of landscapes (Yarwood and Evans, 2000). However, others recommend the use of these particular breeds for nature conservation because of their primitive nature and suitability for free-range grazing, especially where the indigenous wild horses and cattle are now extinct (Bunzel-Drüke, 2001).

It should be mentioned that there are some protected areas in landscapes that have no history of livestock grazing in which it may be inappropriate, and possibly ecologically detrimental, to introduce domesticated animals where they have never been before. Therefore, the following discussion should not be interpreted to suggest that indigenous breeds of livestock are a panacea to solving all nature conservation challenges, even where there is a history of livestock presence within the protected area. Indeed, any livestock grazing programme in ecologically sensitive areas should be carefully planned and monitored, allowing for adaptive management when necessary.

Control of invasive species

Several protected areas made use of indigenous breeds to address the spread of invasive species. A flock of 300 endangered Red Ardennes ewes with lambs was introduced in 1997 to Hautes-Fagnes plateau, Belgium, to control invasions of purple moor-grass (*Molinia caerulea*) on heaths and moors. The sheep uprooted *Molinia* tussocks and opened the litter layer, allowing the germination of plants that tended to become rare with *M. caerulea* invasions (Delescaille, 2002). In Ireland's Killarney National Park, summer to autumn grazing by Kerry cattle at a density of 0.5–1.0 head per hectare effectively reduced the dominance of *M. caerulea* in upland habitats and increased overall plant species diversity compared with control plots without grazing (Dunne and Doyle, 1988). Attempts to control *M. caerulea* through grazing were not always successful. Grazing by indigenous heath sheep in Dutch nature reserves could not curb the spread of this grass, although experiments using cattle were more effective (Piek, 1998).

To restore pasture that had become overgrown with false indigo (*Amorpha fruticosa*) in Lonjsko Polje Natural Park, 19 cows and 1 bull of the critical maintained

Slavonia-Syrmium Podolia cattle breed were acquired by the Croatian Nature Park Public Service. Grazing by this breed, after mechanically mulching the overgrown pasture once, was found to be the most effective means of restoring the pastureland (Gugic, 2008).

Maintaining open environments

Across Europe, habitats associated with traditional agricultural practices are increasing in rarity as pastureland is abandoned, converted to cropland or subjected to intensive rather than extensive grazing systems (Ostermann, 1998; Krebs *et al.*, 1999; Isselstein, Jeangros & Pavlu, 2005). Ostermann (1998) found that of the 198 ecologically important habitats identified by the European Commission's Habitat's Directive, 26 habitats (including eight priority habitats) are threatened abandonment of grazing. The cessation of grazing in semi-natural meadows in Europe often significantly reduces the species richness of non-domesticated plants (Persson, 1984; Hansson and Fogelfors, 2000; Huhta and Rautio, 2005; Pykälä, 2005). Some protected areas resumed grazing by indigenous or at-risk breeds to maintain such habitats and prevent encroachment of woody vegetation in disturbance-dependent ecosystems. For example, in response to encroachment of scrub in previously open marsh habitats, an experiment using Konik horses to graze small patches of marshland in Biebrza National Park, Poland began in the 1970s. Browsing and scratching by horses stopped or slowed encroachment of woody growth in all cases (though the level of effectiveness depended on season and intensity of grazing) and maintained or increased the number of breeding birds of species targeted by the management practice (Borkowski, 2002).

Increasing biological diversity

Livestock grazing in Croatia's Lonjsko Polje had many positive effects on biodiversity, such as seed dispersal by pigs, cattle and horses; creation of sparsely vegetated, shallow, warm pools of water for dragonflies (*Ischnura pumillo* and *Lestes barbarus*); creation and maintenance of amphibian habitat (*Bombina bombina* and *Hyla arborea*); and development of landscape heterogeneity that supports about 300 plant species, including 13 species that are specifically associated with pig pastures (Poschlod *et al.*, 2002).

Soil conservation

In Ecuador, alpacas (*Vicugna pacos*) were purchased in cooperation between the protected area authority, an international development agency, and local communities to encourage community members to reduce the numbers of sheep, which were believed to be responsible for high levels of soil erosion in the Chimborazo Faunal Production Reserve. The alpacas were expected to have less impact on the soil and vegetation, while providing economic development opportunities as breeding stock and as fibre-producing animals (Rosenthal, 2006).

Sustainable development

Although conserving natural environments is a priority of many protected areas, landscapes with a history of anthropogenic influence are increasingly being recognized as ecologically valuable, and in some cases these landscapes are dependent on the continuation of traditional agricultural land use. A special category of protected area (Category V, Protected Landscape/Seascape) was established by the IUCN to acknowledge the importance of conserving areas where interactions between humans (including their livestock) and their environment have "produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity" (Phillips, 2002, p. 9). In these protected landscapes, managers are concerned not only to protect natural biological diversity, they also have a vested interest in promoting the continuation of traditional cultural and economic activities that have helped shape the landscape for generations. Thus, their roles extend beyond simply conserving and monitoring natural environments to incorporating social concerns into protected area management through cooperation with local landowners and forming partnerships for sustainable economic development. Many of the protected areas in which indigenous breeds of livestock are actively being promoted fall within the Category V Protected Landscape designation (Table 2), although such practices can also be justified within the management foci of other protected area categories (Dudley, 2008).

Examples of the synergies among nature conservation, livestock breed preservation and economic development objectives in many of the protected areas involved in promoting the use of indigenous breeds of livestock are summarized below.

Compensation for nature management services

Incentives and cost reductions associated with cooperating with protected areas for conservation grazing may at least partially offset the possible economic disadvantage of working with breeds that are perceived to be commercially inferior because of their smaller carcass size, limited milk production or coarser fibre. Beyond simply allowing indigenous or at-risk breeds of livestock to exist within protected area boundaries, which in itself can reduce costs and help develop positive relationships between local residents and protected area managers (Feremans, Godart and Deconinck, 2006), further economic incentives may be offered to farmers in exchange for the "nature management services" provided by their livestock. For example, in Belgium, herders' wages and winter feed for their livestock is provided by the park service (Delescaille, 2002). In Sweden, funding for bush clearing, fencing, transport

or farm buildings, or payments per head of livestock are offered to farmers involved in conservation grazing programmes (Matzon, 1986). Conversely, Meissner (2006) found that in Romania when farmers were charged a fee to pasture their animals on protected land within the Danube Delta, free-ranging horses were unclaimed by farmers and their numbers increased to the point that they began to overgraze ecologically sensitive areas.

In addition to the economic opportunities associated with conservation grazing, protected area managers contributed to the conservation of domestic animal diversity by initiating or supporting innovative sustainable development strategies involving local breeds of livestock. In Croatia, Ireland and France, for example, protected area authorities initiated "seed herd" programmes in which interested local residents can obtain a small number of breeding animals at no cost to establish their own small flock or herd of a breed in need of conservation. After a few breeding seasons, the recipients must return the same number of breeding animals to the authority which can then be used as another seed herd for an interested resident (Audiot, 1995; Harrington, 2002; Gugic, 2008). Grazing by these animals could also be integrated within the protected areas' vegetation management plans.

Raising livestock within protected areas, using practices that are ecologically beneficial, creates unique marketing opportunities to promote so-called "ecological" products from the meat, milk or fibre of livestock raised in these conditions. In Hungary's Hortobágy National Park, for example, indigenous Hungarian grey cattle, Racka sheep and Mangalica pigs are raised in the traditional extensive manner to maintain grassland vegetation by the Hortobágy Public Company for Nature Conservation and Gene Preservation, a group of nearly 60 herdsmen who manage one-fifth (17 000 ha) of the National Park area – reportedly the largest continuous area of organic agricultural production in Hungary and Europe (Megyesi and Kovách, 2006). Meat from these breeds is featured in local restaurants, appealing to tourists who visit the national park. Similarly, Germany's Rhön Biosphere Reserve encourages direct marketing of local agricultural products such as products from heritage varieties of apples and traditional Rhön sheep through organizing cooking competitions using Rhön sheep products and forming partnerships with a gastronomic association that promotes items "From the Rhön for the Rhön" (Pokorny, 2008).

Research and Public education

Protected areas are often utilized as settings for scientific research. Monitoring of vegetation management strategies discussed in the section above on grazing for nature conservation provides much needed information on the effectiveness of using indigenous or at-risk breeds of livestock for such purposes. Protected areas may also establish partnerships with breeding associations and research institutes to conduct other types of research that aid with the conservation of domestic animal diversity. For example, the French regional park authorities with various partner organizations have undertaken genetic studies, animal health studies, breed inventories, market analyses and the creation and maintenance of breed registries, in addition to research focused on assessing the ecological effects of grazing by local breeds within their protected areas (Audiot, 1995; Martin and Morceau, 2006).

Protected areas may also contribute to public awareness of heritage breeds of livestock as part of their overall public education strategies. Information about local breeds of livestock is available at many park visitor information centres and on several protected area web sites. Other approaches to build awareness include the breeding centre for the Poitou donkey in France's Parc Naturel Régional du Marais Poitevin, which is open to the public and receives approximately 30 000 visitors annually who can view the animals, observe a presentation on the historic mule (*Equus caballus* × *Equus asinus*) breeding industry and visit the breed documentation centre (Martin and Morceau, 2006). Several approaches to raising awareness and promoting acceptance of conservation grazing initiatives using Exmoor ponies and Heck cattle in Germany's Solling-Vogler Nature Park include guided walks, evening lectures, media releases, information boards, a project video and field trips, which are particularly popular (Gerken and Sonnenburg, 2002). Additional plans for building public support for the grazing initiatives in Solling-Vogler Nature Park include leaflets, a book about the project, construction of more nature trails and an "adopt-an-animal" sponsorship programme (Gerken and Sonnenburg, 2002).

Conclusions

Although protected areas are not currently considered a major contributor to the conservation of non-wild animal genetic resources for food and agriculture, they are uniquely positioned to provide incentives for the use of under-utilized non-industrial breeds, particularly within conservation grazing programmes. The ecological benefits provided by such breeds of livestock can be of great value and compensation for these "ecological services" and other cost reductions such as free access to pasture land can offset the potential economic disadvantage to farmers of working with non-industrial, indigenous breeds. In addition to their focus on nature management, protected area managers can facilitate the development of partnerships for sustainable development, including establishing seed herd programmes, and working with farmers to develop value-added products such as organic meat, dairy or fibre production. As tourism attractions, protected areas draw potential customers who may be more likely to value ecologically produced agricultural products. There

are many opportunities for protected area managers and authorities responsible for conserving animal genetic resources for food and agriculture to explore options such as those described in this article to fulfil mutually compatible objectives. Of course, the interactions of livestock and nature are complex and such initiatives should be carefully planned and closely monitored to ensure that domestic animal diversity is conserved without compromising other values of the protected areas involved.

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Category 1: livestock species emphasis = general

Category 2: technical emphasis = conservation

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Conservation status of wild relatives of animals used for food

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Summary
The *Global Plan of Action for Animal Genetic Resources* calls for action to conserve the wild species that are related to livestock. The global conservation status of wild species is monitored through the IUCN Red List. This shows that at present 21 percent of the world's 5 488 mammal species and 12 percent of its 9 990 bird species are threatened with extinction. In contrast, a greater proportion of wild relatives of the major mammal livestock species are at risk of extinction: 44 percent of sheep and goats, 50 percent of pigs and 83 percent of cattle. More wild relatives of the chicken are also at risk (25 percent) than bird species overall. These figures indicate the need to pay much more attention to the relationship between the conservation of biological diversity and human well-being. Therefore, there is an urgent need to coordinate responses to the loss of biodiversity and the reduction in variation that may prove vital for animal genetic resources in the future. Intergovernmental meetings being held this autumn offer the prospect of beginning this process.

Keywords: *wild relatives, Galliformes, extinction risk, conservation status*

Résumé
Le *Plan d'action mondial pour les ressources zoogénétiques* plaide pour une action en faveur de la conservation des espèces sauvages apparentées aux animaux d'élevage. L'état mondial de la conservation des espèces sauvages est suivi par le biais de la liste rouge UICN. Cette liste indique qu'à présent 21 pour cent des 5 488 espèces de mammifères et 12 pour cent des 9 990 espèces d'oiseaux de la planète sont menacées d'extinction. D'autre part, une part plus importante des parents sauvages des principales espèces de mammifères d'élevage est menacée d'extinction: 44 pour cent de moutons et de chèvres, 50 pour cent de porcs et 83 pour cent de bovins. Les parents sauvages des poules sont également plus menacés (25 pour cent) que les espèces d'oiseaux en général. Ces chiffres indiquent qu'il est nécessaire de prêter beaucoup plus d'attention à la relation entre la conservation de la diversité biologique et le bien-être humain. Par conséquent, il est urgent de coordonner les interventions en réponse à la perte de biodiversité et à la réduction de variation qui pourraient s'avérer primordiales à l'avenir pour les ressources zoogénétiques. Les réunions intergouvernementales organisées au cours de cet automne offrent la possibilité de lancer ce processus.

Mots-clés: *Parents sauvages, galliformes, risque d'extinction, état de la conservation*

Resumen
El Plan de acción mundial sobre los recursos zoogenéticos insta a adoptar medidas para conservar las especies silvestres relacionadas con el ganado. El estado de conservación de las especies silvestres a nivel mundial se controla a través de la Lista Roja de la IUCN. Esto demuestra que actualmente el 21% de las 5.488 especies de mamíferos del mundo y el 12% de las especies de aves están en peligro de extinción. Por el contrario, una mayor proporción de los parientes silvestres de las especies de mamíferos de gran talla están en peligro de extinción: el 44% del ganado ovino y caprino, el 50% del porcino y el 83% del bovino. Mayor cantidad de parientes silvestres de las gallinas también se encuentran en peligro de extinción (25%) en comparación con el resto de las aves en general. Estas cifras indican la necesidad de prestar mucha más atención a la relación existente entre la conservación de la diversidad biológica y el bienestar humano. Por lo tanto, existe una necesidad urgente de coordinar respuestas relacionadas con la pérdida de la biodiversidad y con la reducción de la variación que puede resultar vital para los recursos zoogenéticos en el futuro. Las reuniones de carácter intergubernamental que se van a celebrar este otoño ofrecen la posibilidad de dar comienzo a este proceso.

Palabras clave/Términos: *Parientes silvestres, Gallinácea, peligro de extinción, estado de conservación*

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Picture 1. Red junglefowl *Gallus gallus* in Bu Gia Map National Park, Vietnam. Credit: Quang Nguyen Hao.

Introduction

The *Global Plan of Action for Animal Genetic Resources* states that the wild relatives of domestic animal species require protection (FAO, 2007a). However, all analyses indicate that the conservation status of wild species continues to deteriorate (e.g. Vié, Hilton-Taylor and Stuart, 2008; CBD, 2010). It is, therefore, timely to report the current level of extinction risk facing the wild relatives of the main livestock species. This is important for two reasons: first to indicate that the concern over animal genetic resources should not be limited to rare breeds or varieties that have already been domesticated and second, to encourage a formal discussion on ways in which global efforts to conserve animal genetic resources and biodiversity may be harmonized.

Eight years ago, the parties to the Convention on Biological Diversity agreed to reduce the rate of biodiversity loss significantly (CBD, 2003). This is widely known as the 2010 target (see for example Fisher, 2009) and was subsequently included as a target contributing towards the United Nations Millennium Development Goal 7 "Environmental Sustainability" in view of the importance of biodiversity in sustainable development (UN, 2005). Nowhere is this relationship between biodiversity and humans more tangible than in the link between food security and the risk of species extinctions. This is because highly productive breeds of domesticated livestock have replaced local breeds in many parts of the world, leading to a growing concern that genetic resources that may prove vital for safeguarding future food supply are being eroded (FAO, 2007b). Such resources reside not only in local breeds, but also in wild relatives.

The "2010 target" of reducing the loss of biodiversity significantly has not been met (CBD, 2010: see also Butchart *et al.*, 2010) and this has led the United Nations Secretary General to call for a new vision for biological diversity for a healthy planet and a sustainable future for humankind. Safeguarding wild relatives of domesticated animals to ensure food security for future generations offers a clear and immediate option to start responding to this call. In order to start this discussion, I review the conservation status of the wild relatives of the five major livestock species and then use poultry to provide a more in-depth example of the conservation status of a group of wild relatives.

Conservation status of wild relatives

Five livestock animals (cattle, chicken, goat, pig and sheep) account for a significant proportion of the world's meat consumption. The conservation status of the world's wild species is monitored through the authoritative IUCN Red List (see IUCN, 2010). The last major analysis of the list revealed that of the 44 838 species assessed, 16 928 (38 percent) were considered to be threatened with extinction (Vié, Hilton-Taylor and Stuart, 2008). All the estimated 5 488 species of mammals have been assessed and at present 21 percent are threatened with extinction and of the 9 990 species of birds, 12 percent are at risk (Picture 1).

Considering the wild relatives of the five major livestock species, the number of extant wild relatives that are threatened with extinction varies from 44 to 83 percent for the four mammalian livestock species and 26 percent for the chicken (IUCN, 2010; Table 1). These are notably higher than the overall values for mammals (38 percent) and birds (12 percent).

Risk of extinction: the wild relatives of the chicken

The chicken has descended from the red junglefowl *Gallus gallus*, which is one of the most well known of the 50 species of the pheasant that, along with turkeys, partridges,

Table 1. Threat status of the wild relatives of five major livestock species.

Livestock species	Wild relatives		
	Taxonomy	No. of species	% of threatened species
Chicken	Order Galliformes: Families Phasianidae, Numidae, Megapodidae, Cracidae, Odontophoridae	289	25
Cattle	Tribe Bovini within Family Bovidae. Genera *Bos*, *Bison*, *Bubalus*, *Syncerus*	13	83
Sheep and goat	Subfamily Caprinae within Bovidae: Genera *Ammotragus, Arabitragus, Budorcas, Capra, Capricornis, Hemitragus, Naemorhedus, Nilgiritragus, Oreamnos, Ovibos, Ovis, Pantholops, Pseudois, Rupicapra*	36	44
Pig	Family Suidae within the Cetartiodactyla	18	50

Picture 2. Grey junglefowl *Gallus* (*Gallus sonneratii*) in India. Credit: Clement Francis.

Picture 3. Critically endangered Trinidad piping-guan *Pipile pipile* in the Northern Range, Trinidad. Credit: Kerrie Naranjit.

grouse, peafowl, megapodes and cracids make up the Galliformes, an order that contains 289 bird species.

FAO (2009) estimates that there are nearly 17 billion chickens in the world: 2.5 for every person and more than four times the total number of individuals of the other "big five" livestock species (cattle, sheep, goat and pig). The production of poultry is rapidly intensifying and it is the fastest growing subsector in the livestock industry such that in 2007 it accounted for 26 percent of global meat supplies (FAO, 2009). Genetic advances are much faster in animals such as chickens that have short generation times and this has contributed to the commercial poultry industry pursuing technological improvements far more vigorously than other subsectors. All this means that genetic variation is being reduced as high yield strains increasingly dominate with both intensification and expansion of industrialized production (Picture 2).

At the same time, rural people are more likely to own poultry and small ruminants rather than larger livestock (FAO, 2009) and so the global distribution of resilient local breeds of poultry may be important in efforts to reduce food insecurity at a local level. Consequently, conserving wild relatives of chickens may serve to maintain and enhance food security at both global and local levels.

Therefore, it is of considerable concern that a higher proportion of wild relatives of the major livestock species are at risk of extinction than are all mammals and all birds. Analysing extinction risk in more detail for the chicken's wild relatives indicates that there appears to be an ongoing process of extinction: two species have already become extinct (since the baseline year of 1600), one is currently known only in captivity (i.e. considered extinct in the wild) and five are considered to be critically endangered, which means that they have a very high probability of extinction in a very short time period (IUCN, 2010; Table 2) (Picture 3).

The reason for this high level of extinction risk appears to be overexploitation. While the majority of species are subject to some form of negative habitat change because of human activity, it is the degree to which Galliformes are thought to be hunted or their eggs collected that sets them apart. McGowan and Garson (2002) reported that overexploitation was a problem for more than 90 percent of the threatened Galliformes because their relatively large size and ecology made them attractive to hunters. Many species also feature in rural traditions, such as feathers of the great argus pheasant *Argusianus argus* being used in headdresses of the Dyaks of Borneo and the Indian blue peafowl *Pavo cristatus* important to Hindus as the vehicle of the god Kartikeya, the son of Lord Shiva and Parvati.

Discussion

A higher proportion of wild relatives of the major livestock species are at risk of extinction than for all mammals and birds. Conserving these wild relatives was identified as important in the *State of the world's animal genetic resources* (FAO, 2007b). However, the high level of threat revealed here suggests that the need to pay attention to wild relatives is increasingly urgent.

Table 2. The pattern of threat in the wild relatives of the chicken (the Galliformes).

Threat category	Number of species	Cumulative percentage of all species
Extinct	2	1
Extinct in the wild	1	1
Critically endangered	5	3
Endangered	24	11
Vulnerable	43	26
Near-threatened	39	39
Least concern	175	100
Total	289	

Analysis of the risk of extinction faced by the wild relatives of the chicken indicates that two species have become extinct and several others are considered to be at high risk. Unless action is taken, it is to be expected that those species with a lower degree of risk will move into higher threat categories.

The year 2010 is the International Year of Biodiversity and with a suite of intergovernmental meetings taking place towards the end of the year, the opportunity must be seized to coordinate our responses with the loss of biodiversity and the reduction in variation that may prove vital for animal genetic resources in the future. Opportunities to develop this coordination include the United Nations high-level biodiversity discussion at the 65th sitting of its General Assembly in September, the 10th Meeting of Parties to the Convention of Biological Diversity in Nagoya, Japan and the 13th Regular Meeting of FAO's Commission on Genetic Resources for Food and Agriculture. Many of the necessary international commitments and agreements are in place that will allow near-term and longer-term targets and goals to be achieved, but there is a clear need for clearer links and stronger coordination.

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Statement of interest

The author is Director of an international organization that is dedicated to the conservation of the Galliformes.

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Livestock keepers' rights: the state of discussion

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Summary
Livestock keepers' rights (LKR) is a concept developed by civil society during the "Interlaken process" and is advocated for by a group of non-government organizations, livestock keepers, pastoralist associations and scientists who support community-based conservation of local breeds. This study provides an overview of the rationale, history and content of LKR and suggests that biocultural or community protocols are a means of invoking the principles of LKR even in the absence of their legal enshrinement. It is concluded that besides striving for legal codification of LKR its principles should form the basis of pro-poor and ecological livestock development in general.

Keywords: *livestock keepers' rights, biocultural protocols, international regime on access and benefit-sharing, guidelines*

Résumé
Le concept des droits des éleveurs a été développé par la société civile au cours du «processus d'Interlaken». Ils sont défendus par un groupe d'organisations non gouvernementales, d'éleveurs, d'associations de pasteurs et de scientifiques qui soutiennent la conservation des races locales au niveau communautaire. Le présent document fournit une vue d'ensemble de la justification, de l'histoire et des contenus des «droits des éleveurs» et suggère que les Protocoles bioculturels ou communautaires représentent un moyen pour invoquer les principes de ces droits même s'ils ne sont pas juridiquement garantis. Le document arrive à la conclusion qu'en plus de s'efforcer d'atteindre la codification juridique des droits des éleveurs, il faudrait utiliser leurs principes de façon générale en tant que base pour le développement de l'élevage écologique et en faveur des pauvres.

Mots-clés: *droits des éleveurs, protocoles bioculturels, Régime international relatif à l'accès et au partage des avantages, lignes directrices*

Resumen
Los derechos de los propietarios de ganado es un concepto desarrollado por la sociedad civil durante el "proceso de Interlaken" y es defendido por un grupo de organizaciones no gubernamentales, propietarios de ganado, asociaciones de pastores nómadas y científicos que apoyan una comunidad basada en las razas locales. Este trabajo proporciona una visión general del fundamento, historia, contenido de los "Derechos de los propietarios de ganado" y sugiere que los protocolos bioculturales y de la comunidad son un medio para invocar los principios de los derechos de los propietarios de ganado; incluso en ausencia de su materialización legal. Se concluye que, además de luchar por la articulación legal de los derechos de los propietarios de ganado, sus principios deben ser la base en beneficio de los pobres y el desarrollo ecológico del ganado en general.

Palabras clave: *Derechos de los propietarios del ganado, Protocolos bioculturales, régimen internacional sobre el acceso y el reparto de beneficios*

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Introduction

Livestock keepers' rights (LKR) is a concept developed by civil society (including non-government organizations and herders' associations) during the "Interlaken process", the run-up to the First International Technical Conference on Animal Genetic Resources held at Interlaken by the Food and Agriculture Organization of the United Nations (FAO) in September 2007 (FAO, 2007). They are advocated for by a group of non-government organizations, livestock keepers, pastoralist associations and scientists who support community-based conservation of local breeds and form the LIFE (Local Livestock For Empowerment of Rural People) Network. LKR are based on the rationale that many breeds in developing countries disintegrate owing to the loss of the traditional rights of livestock keepers to sustain their livestock on common property resources, as well as policies that are adverse to small-scale livestock keepers. LKR are a set of principles

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that – if implemented – would support and encourage livestock keepers to continue making a living from their breeds and thereby achieve the combined effect of conserving diversity and improving rural livelihood opportunities.

Origin and history of LKR

The term LKR was first coined and promoted by civil society organizations during the World Food Summit held in 2002. The expression was an allusion to farmers' rights, which had just been legally enshrined in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). At this point in time, the discussion around animal genetic resources had not yet picked up the enormous importance of livestock keepers in the management of animal genetic resources; in fact, livestock keepers were not even regarded as stakeholders. Having based their argumentation on anthropological rather than animal science data, the proponents sought to emphasize the fact that many traditional livestock keeping communities, especially pastoralists, have developed highly sophisticated knowledge systems and social mechanisms for managing their genetic resources (Lokhit Pashu-Palak Sansthan and Köhler-Rollefson, 2005). Arguing that livestock keepers were indispensable to animal genetic resource management, they claimed that LKR and an equivalent to the ITPGRFA were needed to ensure the sustainable management of animal genetic resources.

Cornerstones of LKR

For the purpose of adding substance to the term LKR, the LIFE Network organized a series of consultations and workshops with representatives of livestock keeping communities and support non-government organizations (NGOs) in Karen (Kenya) in 2003, Bellagio (Italy) in 2006, Yabello (Ethiopia) in 2006, and Sadri (India) and Addis Ababa (Ethiopia) in 2007. Hundreds of livestock keepers representing more than 20 countries participated in these gatherings and identified the threats that undermine the ability of pastoralists and small-scale livestock keepers to continue acting as stewards of domestic animal diversity. In the process, seven key elements or "cornerstones" of LKR were identified that would support small-scale livestock producers to continue maintaining their breeds.

Cornerstones of LKR (Köhler-Rollefson, Rathore and Mathias, 2009)

1. Recognition of livestock keepers as creators of breeds and custodians of animal genetic resources for food and agriculture.
2. Recognition of the dependency of the sustainable use of traditional breeds on the conservation of their ecosystems.
3. Recognition of traditional breeds as collective property, products of indigenous knowledge and cultural expression.
4. Right of livestock keepers to breed and make breeding decisions.
5. Right of livestock keepers to participate in policy-making processes on animal genetic resources issues.
6. Support for training and capacity building of livestock keepers and provision of services along the food chain.
7. Right of livestock keepers to participate in the identification of research needs and research design with respect to their genetic resources so as to ensure compliance with the principle of prior informed consent.

LKR at Interlaken

During the First International Conference on Animal Genetic Resources held at Interlaken (Switzerland) in September 2007, the African region promoted the inclusion of LKR in the Global Plan of Action for Animal Genetic Resources (GPA), but this was opposed by the European and North American regions. As a compromise, the GPA recognizes that "in some countries, livestock keepers have specific rights, in accordance with their national legislation, or traditional rights, to these resources", and that "policy development should take into account . . . the rights of indigenous and local communities, particularly pastoralists, and the role of their knowledge systems". Furthermore, some of the cornerstones are reflected in the GPA. In particular, Strategic Priority No. 5 emphasizes an agro-ecosystems approach to conservation, while Strategic Priority No. 6 focuses on support to "indigenous and local production systems and associated knowledge systems, of importance to the maintenance and sustainable use of animal genetic resources" and recommends various services for livestock keepers, as well as integration of traditional knowledge with scientific approaches, the development of niche markets for products derived from indigenous and local species and breeds, and strengthening of associated knowledge systems.

Subsequently, at the 34th session of the FAO Conference, the issue of LKR was raised again (this time by the government of Brazil) and FAO was requested to look into the "important role of small-scale livestock keepers, particularly in developing countries, as custodians of most of the world's animal genetic resources for food and agriculture in the use, development and conservation of livestock resources". The Commission for Genetic Resources for Food and Agriculture (CGRFA) was tasked with addressing this issue in its report to the 35th session of the FAO Conference in 2009 (FAO, 2009).

The Kalk Bay Workshop

In December 2008, the LIFE Network organized a consultation with African lawyers in Kalk Bay (South Africa) to brainstorm on how to advance the cause of LKR in the

absence of an ongoing international policy process and how to express the cornerstones in legal language. At this juncture, the legal experts deduced that most of the components of LKR were actually already explicitly or implicitly endorsed by a number of existing legal frameworks and international agreements. Among the most important of these is the legally binding Convention on Biological Diversity (CBD), which commits its contracting parties in its paragraph 8j to "subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices". Another supporting international agreement is the UNESCO Convention on the Protection and Promotion of the Diversity of Cultural Experiences, which gives recognition to the distinctive nature of cultural activities as vehicles of identity, values and meaning. Only the right to breed is not specifically mentioned in any existing law.

The legal experts also concluded that the "cornerstones" should be disaggregated into three overarching principles and five specific rights.

Principles:

1. Livestock keepers are creators of breeds and custodians of animal genetic resources for food and agriculture.
2. Livestock keepers and the sustainable use of traditional breeds are dependent on the conservation of their respective ecosystems.
3. Traditional breeds represent collective property, products of indigenous knowledge and cultural expression of livestock keepers.

Livestock keepers have the right to:

1. make breeding decisions and breed the breeds they maintain;
2. participate in policy formulation and implementation processes on animal genetic resources for food and agriculture;
3. appropriate training and capacity building and equal access to relevant services enabling and supporting them to raise livestock and to better process and market their products;
4. participate in the identification of research needs and research design with respect to their genetic resources, as is mandated by the principle of prior informed consent;
5. effectively access information on issues related to their local breeds and livestock diversity.

The three principles and five rights were compiled into a "Declaration on Livestock Keepers' Rights", which puts them in the context of existing legal frameworks (LIFE Network, 2009). The declaration also clarifies the term "livestock keeper", breaking it down into two specific groups: traditional or *indigenous livestock keepers* representing those communities who have a longstanding cultural association with their livestock and have developed their breeds in interaction with a specific territory or landscape and modern "ecological livestock keepers" as those who sustain their animals and the environments, where these animals live, relying largely on natural vegetation or home-grown fodder and crop by-products and without artificial feed additives.

Current status

LKR are frequently referred to as a potential tool for protecting the rights of livestock keepers in a situation where scientists and industries make increasing use of the Intellectual Property Rights (IPR) system to protect their advances in breeding and associated technologies (Tvedt *et al.*, 2007). Some countries have expressed support for the concept of LKR, but it remains controversial, and there is currently no ongoing policy process in which they would become formally enshrined (CGRFA, 2009). As a result, livestock keeping communities and their supporters are developing new tools that protect the rights of livestock keepers and especially support them in traditional ways of life that are a prerequisite for the conservation of local breeds.

Biocultural protocols

Biocultural community protocols (BCPs) put on record the role of a community and its traditional knowledge in stewarding biological diversity. They are a legal tool that was recently developed in response to the need for fair and equitable benefit-sharing agreements under the CBD (UNEP and Natural Justice, 2009). Establishing a biocultural protocol involves a facilitated process in which a community reflects about and puts on record its role in the management of biological diversity, not only its livestock breeds but also its contribution to general ecosystem management. In addition, and maybe even more importantly, the community is also made aware of existing national and international laws – such as the CBD – that underpin the right to *in situ* conservation. The three-part process – documenting, reflecting and learning about rights – can be enormously empowering for a community. The first livestock keeping community that developed a BCP was the Raika of Rajasthan in India (Raika Samaj Panchayat, 2009). Since then several other communities have followed suit, including the Lingayat of Tamil Nadu in India, the Pashtoon Baluch in Pakistan and the Samburu in Northern Kenya. The Raika are using the BCP to contest their customary grazing rights in certain forest areas from which the Forest Department is trying to expel them.

While BCPs have met with great interest among communities, the approach is not without challenges. It requires a skilled mediator that the community trusts, such as a Civil Society Organisation (CSO), an NGO or an individual and with which it has a strong rapport. Establishing a BCP can and should not be done quickly or rushed, because then there may be a danger that a written document will be produced that is not really backed by the community. An important point is that although BCPs were conceptualized in the context of the debate on access and benefit-sharing, their relevance for livestock keepers relates more to the part of paragraph 8j of the CBD, which commits states to protect traditional knowledge and support *in situ* conservation.

Community protocols in the CBD process

Community protocols are explicitly referred to in the draft text for the International Regime on Access and Benefit-sharing (IRABS) that will regulate all access to genetic resources and traditional knowledge and is expected to be agreed upon as a legally binding framework during the tenth Convention of the Parties to the CBD to be held in Nagoya in 2010. IRABS is also expected to provide communities with the option to opt out of the patent system – something they cannot do at the moment. However, in order to do so, communities first need to make visible their role as stewards of biological diversity and for this purpose BCPs are a crucial tool.

Code of conduct/guidelines

At the Kalk Bay Workshop, legal experts recommended developing a "code of conduct" on how to implement LKR. They pointed out that soft law to which stakeholders can voluntarily adhere to is more realistic, because countries are increasingly wary of entering into any legally binding frameworks. Accordingly, two stakeholder consultations took place in Kenya and in India to develop such guidelines. These guidelines are entitled "Supporting livelihoods and local livestock breeds. Guidelines for putting Livestock Keepers' Rights into practice" (LIFE Network, 2010) and are now open for signature at: www.pastoralpeoples.org

LKR in the CBD process

Although indigenous livestock keepers fulfil the criteria of "indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity", they have only just begun to make use of the CBD process for lobbying for their rights. At COP9 that took place in Bonn in 2008, the LIFE Network, the World Initiative for Sustainable Pastoralism and other representatives of livestock keepers made a statement demanding that the contribution of pastoralists to the conservation and sustainable use of biodiversity is recognized and rewarded in accordance with the commitments made by contracting parties in articles 8j and 10 of the CBD, but without reference to LKR.

More recently, the process of developing BCPs has strengthened the movement to make an intervention at the Meeting of the Ad hoc Working Group on paragraph 8j of the CBD in Montreal in November 2009 in which the working group was requested to consider and reflect on the special situation and needs of pastoralists when making recommendations on the international regime in order to ensure their continued contribution to the conservation of biological diversity.

Conclusions

Although LKR were originally modelled on farmers' rights as articulated in the ITPGRFA, they have evolved into a much more comprehensive concept than farmers' rights by not being restricted in scope to the right to breed, save and exchange genetic material but by encompassing a broader approach that would strengthen small-scale livestock keepers and support them to make a living in their traditional agro-ecosystems (Köhler-Rollefson *et al.*, 2009).

Most of the principles and rights are reflected in existing international agreements, including the Interlaken Declaration, the GPA, the UN CBD and the UNESCO Convention on the Protection and Promotion of the Diversity of Cultural Experiences. The one exception is the right to breed and make breeding decisions.

While the crucial role of small-scale livestock keepers and their locally evolved breeds in biodiversity and ecosystem conservation has now become widely recognized at least on paper, international policies, especially free trade agreements, continue to support the proliferation of the large-scale intensive livestock production system relying on a very small number of high-performance breeds and strains. At the same time, general development trends, including population trends and land-grabbing, undermine the existence of the extensive livestock production systems that make use of local resources and conserve biodiversity. If small-scale ecological livestock keepers are to survive, they need more than recognition on paper: They require strong support, and their basic rights – which are already implicit in existing legal agreements, such as the CBD – must be secured and enforced. While BCPs and the code of conduct are useful tools, they are unlikely to be strong enough, unless backed by law.

It would be extremely important to adopt the elements of LKR as guiding principles for livestock development in general. If the same donors that promoted cross-breeding and replacement of indigenous with exotic breeds – often by investing enormous sums of money – were to support livestock keepers in developing local breeds, in organizing

themselves, and in niche and added value product marketing, they would make a major contribution to saving biodiversity and to creating rural income opportunities.

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Regional issues on animal genetic resources: trends, policies and networking in Europe

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Summary

European countries are individually and in collaboration carrying out active work on animal genetic resources (AnGR). The region has a very good starting point for work on AnGR: The breed concept was developed in Europe; current European mainstream breeds are derived from local breeds and, in many species, have further formed the core of the international breeds; there has always been very active research in Europe on farm animal genetics and breeding, including sustainable utilization and management of variation.

Since the 1970s and 1980s many European countries have been paying attention to local breeds and have saved many of them from total extinction. In quite a few countries, the conservation work has been supported by cryopreservation. In the Food and Agriculture Organization of the United Nations (FAO) coordinated process, Europe has actively contributed to assessing the State of the World's Animal Genetic Resources and will continue to implement the Global Plan of Action. There are now national action plans in most of the European countries.

The European consumption of animal products has changed very little over recent decades. At the same time, production has become very intensive. Among other driving forces, the development of agriculture is steered by the EU policies. The last decade has seen new kind of thinking and measures directed towards an overall consideration of rural development. This has given room for the revitalization of many local breeds. The aim is to have schemes that promote the self-sustainability of local breeds. The EU also has a very ambitious research programme to support these aims while enhancing the overall sustainable production and management of biological resources.

The European Regional Focal Point for Animal Genetic Resources (ERFP) is a common forum for the coordinators of European national programmes on AnGR. There are also many non-governmental organizations (NGOs) working in the animal sector. These NGOs and networks are most relevant to raising awareness about the importance of values of AnGR and in enhancing activities that contribute to conservation and sustainable use of AnGR.

Keywords: *genetic resources, animal production, conservation, animal breeding, sustainability, rural programmes, local breeds*

Résumé

Les pays européens travaillent activement, tant séparément qu'en collaboration, dans le domaine des ressources zoogénétiques. La région dispose d'un excellent point de départ pour le travail sur les ressources zoogénétiques: le concept de race a été élaboré en Europe; les races européennes courantes dérivent des vielles races locales et, dans de nombreuses espèces, ont en outre formé le noyau des races internationales; en Europe, la recherche sur la génétique et sur la sélection des animaux d'élevage a toujours été très dynamique, notamment en matière d'utilisation durable et de gestion de la variation.

Depuis les années 70 et 80, de nombreux pays européens prêtent beaucoup d'attention aux races locales et en ont sauvé plusieurs de la disparition totale. Dans un assez grand nombre de pays, le travail de conservation est soutenu par la cryoconservation. Dans le cadre du processus coordonné par la FAO, l'Europe a activement contribué à l'évaluation de L'état des ressources zoogénétiques pour l'alimentation et l'agriculture dans le monde et poursuivra dans la mise en œuvre du Plan d'action mondial. Dans la plupart des pays européens, les Plans d'action nationaux sont à présent en place.

Au cours des dernières décennies, la consommation européenne des produits d'origine animale n'a pas beaucoup changé. En même temps, la production est devenue très intensive. Le développement de l'agriculture est principalement dirigé par les politiques de l'UE. Au cours de la dernière décennie, on a assisté à une nouvelle façon de penser et à la mise en œuvre de mesures favorisant une prise en compte globale du développement rural, ce qui a rendu possible la réapparition de nombreuses races locales. Le but est d'avoir à la disposition des plans visant à promouvoir l'autogestion durable des races locales. L'UE dispose également d'un programme de recherche très ambitieux qui soutient ces objectifs tout en favorisant la production durable et la gestion des ressources biologiques en général.

Le Centre de coordination européen pour les ressources zoogénétiques est un forum commun pour les coordinateurs des programmes nationaux européens sur les ressources zoogénétiques. De nombreuses organisations non gouvernementales travaillent également pour

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ce secteur dans le cadre de la production animale en général et dans la conservation des ressources zoogénétiques et dans la sélection animale en particulier. Ces ONG et ces réseaux sont particulièrement utiles dans les actions de sensibilisation sur l'importance des valeurs des ressources zoogénétiques et dans l'amélioration des activités en faveur de la conservation et de l'utilisation durable des ressources zoogénétiques.

Mots-clés: *Ressources génétiques, production animale, sélection animale, durabilité, programmes ruraux, races locales*

Resumen

Los países europeos están, tanto individualmente como en colaboración, llevando a cabo un trabajo activo sobre los recursos zoogenéticos (AnGR por sus siglas en inglés). La región tiene un muy buen punto de partida para trabajar en los AnGR: el concepto de raza se desarrolló en Europa; las actuales razas europeas reconocidas descienden de las antiguas razas autóctonas y, en muchas especies, han formado la mayor parte del núcleo de las razas internacionales; ha existido siempre una investigación activa en Europa sobre los recursos zoogenéticos y mejora genética, incluida la utilización sostenible y la gestión de la variación.

Desde la década de los setenta y los ochenta muchos países europeos han prestado atención a las razas autóctonas y han salvado a muchas de ellas de su total extinción. En bastantes países el trabajo de conservación se ha basado en la criopreservación. En el proceso de coordinación de la FAO, Europa ha contribuido activamente a la evaluación de La situación de los recursos zoogenéticos mundiales y seguirá implementando el Plan de acción mundial. Actualmente existen Planes de acción nacionales en la mayor parte de los países europeos.

El consumo de productos de origen animal en Europa ha cambiado muy poco a lo largo de las últimas décadas. Asimismo, la producción se ha intensificado notablemente. El desarrollo de la agricultura está regido principalmente por las políticas de la UE. En la última década hemos sido testigos de una nueva corriente de pensamiento y de unas medidas orientadas hacia una consideración mundial del desarrollo rural. Esto ha dado lugar a la revitalización de muchas razas autóctonas. El objetivo es contar con esquemas que promuevan el auto-sostenimiento económico de las razas autóctonas. La UE posee también un programa de investigación muy ambicioso para apoyar estos objetivos al tiempo que mejora la producción en general y la gestión sostenibles de los recursos biológicos.

El Punto focal europeo para los recursos zoogenéticos (ERFP por sus siglas en inglés) es un foro común para los coordinadores de los programas nacionales europeos sobre los AnGR. También existen muchas organizaciones no gubernamentales que trabajan en pro del sector de los animales de producción en general y de la conservación de los AnGR y en la mejora animal en particular. Estas ONGs y las redes son esenciales para crear conciencia acerca de la importancia de los valores de los AnGR y ponen de relieve las actividades que contribuyen a conservar y utilizar de forma sostenible los AnGR.

Palabras clave: *Recursos genéticos, producción animal, mejora animal, sostenibilidad, programas rurales, razas autóctonas*

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Introduction

Global Plan of Action provides a new framework

The need to enhance conservation and sustainable use of farm animal genetic resources (AnGR) reached a major milestone when the Global Plan of Action (GPA) and the Interlaken Declaration on Animal Genetic Resources (FAO, 2007c) were adopted. These documents set out the objectives and commitment for the work on AnGR. Their text fully responds to the obligations set out by the process following the Convention on Biological Diversity (CBD) to conserve AnGR as part of biodiversity, to ensure their sustainable use and to provide for equitable sharing of the benefits arising from their use. The first two pillars are comprehensively covered in the GPA and the text for the third pillar urges countries, under the Food and Agriculture Organization of the United Nations (FAO) coordination, to review their needs as regards access and benefit sharing (ABS) issues.

The core of the GPA is made of four priority areas: (1) characterization, inventory and monitoring of trends and risks; (2) sustainable use; (3) conservation; and (4) policies, institutions and capacity building. Of the four important priority areas, the European region was very particularly keen to emphasize the sustainable use priority area. This interest is due to the need to improve the self-sustainability of local breeds and to pay attention to selection goals and maintenance of genetic variation in intensively selected mainstream breeds. Many European countries have, over the last few decades, worked actively in creating inventories of their AnGR and in implementing actions to enhance conservation and sustainable use of AnGR. National programmes include strategies and actions to rescue rare breeds and measures aiming to re-establish the self-sustainability of local breeds. On the other hand, there is still an urgent need for further action to halt the loss of diversity and to promote sustainable use. Both *in situ* and *ex situ* strategies need to be strengthened. In some countries, better data management might be needed, while in other countries emphasis may need to be placed on issues such as cryopreservation. In many countries, contingency plans are not in place.

Europe strongly contributed to the GPA

The preparation of the GPA was strongly based on contributions from countries. The country reports contained not just information on the state of AnGR within individual countries, but also an analysis of the country's capacities in the area and future needs. It is probably not an exaggeration to say that before the country reports, AnGR were considered as consisting of only rare or forgotten local breeds. The new survey opened participants' eyes and allowed them to look into questions in a new way and to think about the state of the animal production sector as a whole and about its potential for development. European countries were very keen on reviewing their animal production and development work and the related AnGR. The individual country reports are available to view on DAD-IS (Domestic Animal Diversity Information System). The outcome of the European country reports have also been summarized (FAO, 2007a) and annexed to the State of the World's Animal Genetic Resources for Food and Agriculture (SoW-AnGR; FAO, 2007b). European experts have actively taken part in writing thematic studies and individual chapters in the SoW-AnGR. The topics have covered areas like regulatory options for exchange and sustainable utilization of genetic variation and genomics.

Current policy issues: GPA implementation and ABS regime

Implementation of the GPA on AnGR is one of the priority areas in the Multi Year Programme of Work of the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA). Moreover, as the Conference of the Parties of the CBD have been discussing an international regime on ABS, and the 11th Regular Session of CGRFA also agreed on the importance of considering ABS in relation to all components of biodiversity for food and agriculture, an international regime on ABS under the CBD is likely to be a framework regime requiring further elaboration for specific genetic resource areas. Animal Genetic Resources for Food and Agriculture forms one such area. In particular, an important unanswered question is: Which specific policies and measures might best constitute components of an international regime specific for AnGR?

At first sight, international exchange and use of AnGR might seem to take place relatively unhampered, and without strong government policy interference, with the exception of veterinary protection measures. The exchange of breeding animals and semen is active and occurs on a regular basis. Questions related to the ownership of AnGR and ABS have been mostly ignored, except the patenting of new tools, which exploit molecular genetics. Some potentially unfair process patents have also triggered discussion on ABS-type issues. However, the likely adoption of an international regime on ABS justifies a consideration of current practices against the background of new generic rules on ABS. Clearly in strengthening national programmes and in tackling international questions, there is much work ahead and active discussion is needed within and between countries.

The plant genetic resources community has experienced a different kind of development. Plant varieties have been protected since the early 1960s. At the same time, diversity-rich regions and developing countries have been emphasizing the benefit sharing issues and plant breeders have been interested in the facilitation of easy access to genetic resources. These are some of the key motivations for adopting the International Treaty for Plant Genetic Resources for Food and Agriculture (2004). Although the practices for AnGR are very different (e.g. Hiemstra *et al.*, 2006), it is worth thinking about the political implications and possible benefits of the development of common guidelines or recommendations or even, perhaps, a formalized agreement on AnGR. This would clarify the issues involved and remove uncertainties. It would certainly give the sector the visibility and recognition it deserves.

The aim of this article is:

1. to describe developments and trends in Europe related to AnGR conservation and use;
2. to introduce European policies and major actors, stakeholders and networks.

With this publication we also want to show that AnGR conservation and sustainable use are a matter of different policy areas that can contribute to the same objective. There are lots of opportunities to support and enhance agrobiodiversity in Europe.

State of AnGR and animal production in Europe

European trend in production and consumption and international trade

The use of AnGR follows the trends in the livestock sector, in particular trends in food consumption. There is an increasing demand in global consumption of animal protein. On average, per capita consumption of animal-derived food is highest among high-income groups and growing fastest among lower- and middle-income groups in countries that are experiencing strong economic growth. People in industrialized countries currently derive more than 40 percent of their dietary protein intake from food of livestock origin, and there has been little change in this proportion in the last two decades (Steinfeld *et al.*, 2006). Some higher-income sections in societies are cutting down on these components in diet for a number of reasons including health, ethics and an altered level of trust in the livestock sector.

There is some heterogeneity among European countries in the trends in production and consumption, but overall the

state and changes follow the patterns seen in developed countries. Between 1985 and 2008, the total meat production in Europe stayed the same or decreased slightly. Only poultry production experienced considerable increase, with the annual rate being 2.5 percent. Pork production fluctuated over the 20-year period with hardly any overall increase and beef production actually declined by one-third. In Europe, the number of dairy cows is now less than half of what it was 20 years ago while owing to higher yield the total milk production has decreased only by 20 percent. Consequently, more dairy products are now imported to Europe (FAO, 2009).

In many European countries, livestock production and merchandising are a significant business, accounting for half of the agricultural gross domestic product. The last decades have seen the transition from extensive to intensive production. These changes have often been accompanied by major negative environmental consequences. Consumers perceive organic farming as a sustainable way to produce food. Many European farms have switched to certified organic production. Within EU, some 4 percent of the farmed area belonged to organic agricultural production in 2005 with much variation across countries. The area was highest (11.0 percent) in Austria, while in many other countries less than 1 percent (European Commission, 2009).

For Europe, population growth has very much ceased and moderate economic growth is expected. For these reasons, no major changes in demand can be expected. Poultry, pork and cheese production are expected to increase by 10 percent in the next 10 years while butter and beef consumption will reduce by some 5 percent. In the context of increased yields per head and strict quota rules, the EU dairy herd is projected to fall. This is a major factor driving the decline in EU beef production (Table 1, OECD-FAO Agricultural Outlook, 2009–2018).

The trade balances in animal products have recently changed and this is expected to continue in the coming years. From the European perspective, this is linked with growing demand in developing countries and EU policy reforms. The proportion of world exports supplied by Europe is projected to decrease. Moreover, the global threat of disease outbreaks and their after-effects are a dampening factor affecting otherwise generally positive prospects for world meat trade (Silvis, 2006).

State of European AnGR

The trends in the livestock sector in Europe during the past decades have gone hand in hand with the use of specialized breeds and hybrids. A few international mainstream breeds dominate animal production and mainstream breeds of the past became rare breeds. Table 2 (FAO, 2007b) shows that more than 20 percent of the European breeds are reported as extinct and about 30 percent of them are "at risk". The percentage of breeds with status unknown is less than in other regions; however, the high number of breeds at risk is still worrying.

In this context of global breed statistics we also must realize that "breed" is a European concept. Although there are different breed definitions in use, in the European context, a "breed" is an important conservation entity. However, maintaining within breed diversity or "overall allelic diversity" is as important as maintaining breeds.

History of breed development

Over centuries, livestock populations have been divided into a number of subpopulations, because of geographical isolation, selection by their human keepers and other evolutionary forces. These subpopulations may loosely be termed as breeds. We can argue that breed is often also a cultural term.

The year 2009 celebrated Darwin, as it was 200 years from his birth and 150 years from the publication of *The Origin of Species* (Darwin, 1859). He was very familiar with domestic animals, and to denote the difference from natural selection or unconscious selection, he called the farmers' and breeders' work "artificial selection". Prior to Darwin, species and breeds were considered fixed and idealized types with no meaningful variation, which made Darwin sarcastically consider "that there formerly existed in Great Britain eleven wild species of sheep peculiar to it".

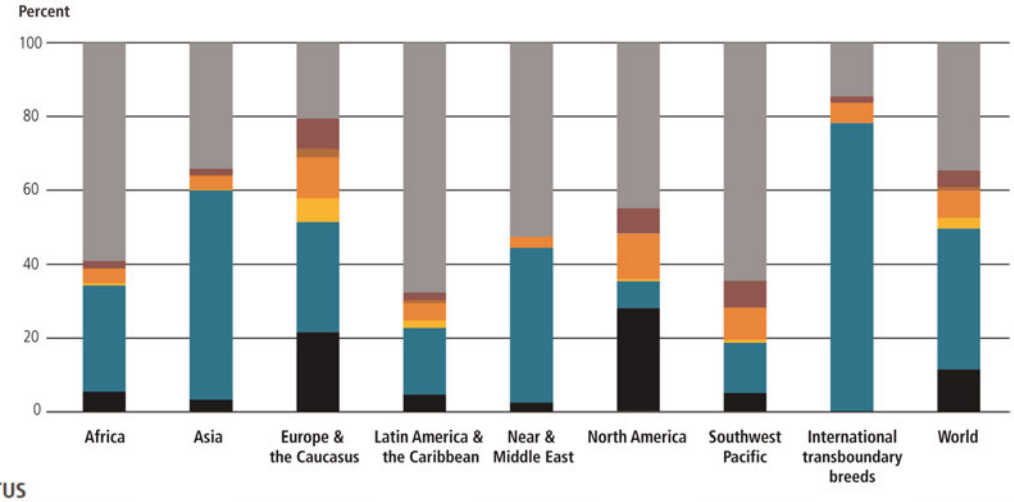
Livestock shows have had an effect on emphasizing the ideas about the correct conformation and colour. Intentional inbreeding was sometimes used to remove the heterogeneity within a breed. While most of the European breeds are fairly uniform by their image, there are exceptions. For example, European goat breeds are phenotypically very heterogeneous. In Iceland, a uniform outlook has never been a target in cattle, sheep or horse, while variation in colour has been much appreciated (Adalsteinsson, 1991).

Table 1. The actual and predicted changes in cattle, pig and chicken sectors in Europe.

Year	Beef 10^6 tn	Pig meat 10^6 tn	Chicken meat 10^6 tn	Milk 10^6 tn	No. of dairy cows 10^6	Milk yield (kg per cow)
1985[1]	18	26	9	275	89	3080
2008[1]	11	26	12	210	41	5120
2018[2]	−4%	+9%	+8%	+2%		

[1]Production in whole Europe (source: FAOSTAT).
[2]Predicted change in production over the period 2008–2018 in EU-27 countries (source: OECD-FAO).

Table 2. Risk status of the world's mammalian breeds in January 2006 (figures by region) (copied from the SoW report, FAO, 2007b).



RISK STATUS	Africa	Asia	Europe & the Caucasus	Latin America & the Caribbean	Near & Middle East	North America	Southwest Pacific	International transboundary breeds	World
unknown	384	469	459	304	107	79	80	58	1 940
critical	13	23	182	9	0	12	9	7	255
critical-maintained	0	4	51	4	0	0	0	0	59
endangered	26	50	249	21	6	22	11	22	407
endangered-maintained	4	3	142	9	0	1	1	0	160
not at risk	187	776	664	81	85	13	17	312	2 135
extinct	35	45	481	21	5	49	6	1*	643
Total	649	1 370	2 228	449	203	176	124	400	5 599

Developments in animal breeding

Gibson and Pullin (2005) describe several phases of livestock breeding in industrialized countries. In the nineteenth century, urbanization and the development of more intensive agriculture led to the stabilization of many breeds as distinct genetic entities through the establishment of breed societies that defined breed characteristics and purity. The first pedigree books were established in Great Britain as early as in the eighteenth century. The turn of the twentieth century was a very active period in the foundation of breeding associations. Local breeds were seen as a part of national identity.

Breeds that were better adapted to modern production systems became more widespread, while other breeds consequently declined and even became extinct in a considerable number of cases (FAO, 2007b). In the middle to late twentieth century, modern within-breed genetic improvement programmes became widely established. This was coupled with specialization in the livestock sector, extensive use of crossbreeding, and the rise of breeding cooperatives and companies. Animal breeding was modernized by market growth, transport and communication, and an improved understanding of genetics.

Primary production with specialized breeds is part of a standardized and efficient food chain that is very much controlled by national, and also more and more by international, commercial operators. Although mainstream breeds stem from local breeds, the major factors driving the livestock sector are often a threat for less competitive and marginalized local breeds. On the other hand, the last two decades are showing how European/national policies and stakeholder strategies can positively influence the future of local cattle breeds. Since European countries committed themselves to international obligations to conserve and sustainably use AnGR (CBD, FAO GPA), national action plans are being developed. National action plans are now including strategies and measures on how to maintain local cattle breeds and how to make them more self-sustaining.

Global exchange and the rise of global players in animal breeding

Over the recent decades, the exchange of breeding animals within Europe has been very active. The global gene flow has been mainly between the countries in the north, less so from north to south or from south to south. Compared with these flows, there is very little south to north exchange. Among the five major livestock species – cattle, sheep, goat, pig and chicken – the internationalized breeds are dominating the breed spectrum in the world. In cattle,

eight of the most popular breeds have a European origin. The most important is the Friesian dairy breed with its North-American Holstein upgrade. Charolais is the most widely used of the pure beef breeds. In sheep the European dominance is lower, with five of the top ten breeds and the figures are much lower for goats. All five leading pig breeds are European (FAO, 2007b).

In terms of the number of active breeding organizations or breeding companies, European companies and cooperatives have obtained a substantial market share. Breeding material or breeding stock from European breeding industry forms the basis for a large share of global cattle, pig or poultry production. For example, in the poultry industry, a small number of multinationals are actively selling highly specialized hybrid layers and broilers, using a very limited number of intensively selected breeding lines. Similar developments could also be seen in the pig and cattle sector.

Common policies

Common Agricultural Policy since the late 1950s

Agriculture has always been one of the most important sectors in European policy. Although not all European countries are part of the EU, non-EU countries have gone through similar developments as EU countries. The first Common Agricultural Policy (CAP) was set as early as 1957. There was a need to make agriculture more productive to meet the requirements for more stable markets and for moderately priced food. The farmers' living standards were also hoped to be improved. The objectives were gradually realized and eventually over-realized, so that discussion over decades changed to overproduction, trade distortion and environmental questions. The 1990s have seen reformations in the CAP aiming at moving agriculture towards market principles and at the same time becoming more sustainable. At the same time, policies have been widened to cover rural activities other than agriculture, such as on-farm food processing and tourism.

Policy changes in agriculture and rural development

As a result of the CAP reform, adopted by the European Council in 2003, subsidies became more independent from the volume of production and rather linked to environmental, food safety and animal welfare standards. The goals for rural development are achieved through diversification. Farmers are encouraged to take part in new kinds of activities directed towards e.g. biodiversity and environmental services, as conventional agriculture is no longer an automatic source of income.

Management of AnGR in Europe can also benefit from this shift in CAP. The European legal framework provides for financial support to be given to farmers rearing farm animals of "local breeds indigenous to the area and in danger of being lost to farming" in the context of rural development objectives and agri-environmental programmes.

In the world or even within a region, like Europe, there is wide heterogeneity among animal production systems and the use of local or mainstream genetic resources. Common policies have to be comprehensive enough to be adapted to specific breed cases, their needs, and national or regional specificities. At the European level, a number of policy areas might, directly or indirectly, promote or hamper the use of local breeds. For example, livestock biodiversity and rural development objectives can be easily connected, or strict sanitary measures should not unnecessarily hamper the conservation and use of local cattle breeds. Common policies should avoid unbalanced effects across countries and should be accompanied by local policies tailored to specific country/breed situations ("one size does not fit all").

Veterinary and zootechnic legislation

The EU has identified food safety as one of its top priorities and has developed considerable legislation regulating the safety of food, including animals and animal products. Because of newly discovered health hazards and newly developed technologies, such as genetic engineering, EU legislation with regard to food has recently undergone significant reform.

The EU legislative framework for food safety affects livestock production and marketing, and hence the utilization of AnGR. The legislative texts are designed primarily to regulate imports and intracommunity trade involving animals and animal products.

The situation on animal diseases in Europe remains very good, despite the recent issues such as BSE (Bovine Spongiform Encephalopathy) and foot and mouth disease. Modern animal production is more affected by multifactorial syndromes related to poor housing, feeding or hygiene. At present, the veterinary control and eradication schemes in Europe are so effective that any emerging major disease is quickly removed (Cunningham, 2003).

EU legislation related to animal breeding is contained in the Community's zootechnical legislation. This legislation aims to promote free trade in breeding animals and genetic material while considering the sustainability of breeding programmes and conservation of genetic resources.

The aims are reached by harmonized recognition of breeding organizations, pedigree certificates, criteria governing entry in herd books, performance testing, and genetic value assessment and acceptance for breeding purposes.

Programme GENRES 870/04

In the Biodiversity Action Plan for Agriculture, the European Commission proposed to launch a new community programme on the conservation, characterization,

collection and utilization of genetic resources in agriculture. The community programme, which has been established by Council Regulation (EC) No 870/2004, promotes genetic diversity and the exchange of information including close coordination between member states and between the member states and the European Commission. The budget allocated to this programme, which complements the actions co-funded by the new Rural Development Council Regulation (EC) No 1698/2005 [Article 39(5)], amounts to EUR 8.9 million. The community programme co-funds 17 actions, involving 178 partners located in 25 member states and 12 non-EU countries. The actions started in 2007 and have a maximum duration of 4 years. There are five projects dealing with AnGR (http://ec.europa.eu/agriculture/genetic-resources/actions/index_en.htm). The first community programme, established by Council Regulation (EC) No 1467/1994, gave rise to 21 projects, with a total EU co-funding of around EUR 10 million in 1996–2005.

Incorporation of AnGR in different policy areas

Over the years, the EU has shown much interest in incorporating issues of genetic resources in policy making. The member states coordinate their common position at the council level and the member state holding the presidency expresses the EU position at FAO level. So far, the AnGR issues are dealt by several directorate generals: SANCO (Health and Consumer Affairs – zootechnics, animal health), AGRI (Agriculture and Rural Development – CAP), ENV (Environment – follow-up of CBD), RTD (research) and DEV (Development – FAO-issues). Currently, the European Commission, however, lacks expert units devoted solely to AnGR issues. The work on AnGR would benefit if there was a single body dealing with animal breeding and conservation issues within the EU, as it is the case for plants. The common legislation has harmonized national legislation in EU countries and raised the awareness on the importance of sustainable conservation and utilization of AnGR. EU is emphasizing the need for achieving profitable production for all farm animal breeds. The patent rights are defined in Europe by the European Patent Convention and EU has adopted a directive for biotechnological patents, which is setting special rules for the grant and scope of the protection for this type of patents (98/44/EC). This directive has rules targeting patents on both plant- and animal-related inventions.

Modern approaches in the management of AnGR

Sustainable breeding programmes

Modern animal breeding has moved from selection on single traits (e.g. growth, leanness, milk production and egg production) to selection for multiple traits that balance production, reproduction, product quality and animal robustness characters.

Sustainability of a breeding programme has many aspects worth considering. A wide-ranging discussion on them is given by Woolliams *et al.* (2005) with some of them presented here. (1) The objectives in the operations should be shared by all the stakeholders in the production chain. The development schemes should also address socio-economic impact (rural economy, national economy, subsidies and export/import), public perception on breeding technology and environmental consequences (quality of environment and landscape management). (2) The analysis of demand and market should take into account political and economic global and national trends, and the preference by the consumers and the society. Fragmentation in consumption habits and marketing is an important factor in modern societies. (3) The recording schemes are an integrated part of production in farms. The more expensive schemes involve health and welfare traits and molecular genetic typing of animals. (4) A breeding and conservation scheme should be designed to avoid genetic risks owing to a low number of parents, which may cause genetic drift or even inbreeding depression. A breeding programme needs backup storage of genetic material in frozen semen and embryos to replenish the genetic variation in the future. Another type of risk is that the long-term results in breeding programme may deviate from the desired ones because of ignorance of unfavourable side-effects owing to narrowly focussed selection. (5) Importation planning should also take into account the possible risks of diseases. Avoiding continued dependence on importation is in this sense very wise. (6) The best possible experts should be used in development, planning and operative work. For example, if the marketing is not done professionally, domestic or international operations may fail in gaining new market ground or in maintaining the existing one.

Revolutionary genomic tools

Genomics research has made impressive progress in recent years. Genomic tools have been exploited widely in many areas, in characterizing the diversity of farm animal populations and in locating genes (QTL, quantitative trait loci) mediating the variation in production, health and reproduction traits. Assuming that the DNA markers being used are neutral, with a number of independent markers it is possible to find out which marker alleles are common or different among related breeds and thereby estimate the relationships among breeds. Pig breed diversity was assessed using 50 microsatellites (SanCristobal *et al.*, 2006). The neighbour-joining tree drawn from the Reynolds distances among the breeds showed that the national varieties of major breeds and the commercial lines were mostly clustered around their breeds of reference (Duroc, Hampshire, Landrace, Large White and Piétrain). In contrast, local breeds, with the exception of the Iberian breeds, exhibited a star-like topology.

In sheep, levels of heterozygosity were slightly higher in southern than in northern sheep breeds, consistent with declining diversity with distance from the near eastern centre of domestication (Lawson *et al.*, 2007). The diversity study on goats (Cañón *et al.*, 2006) also supports the hypothesis that domestic livestock migrated from the Middle East towards western and northern Europe and indicate that breed formation was more systematic there than in the Middle East. The studies have been used to find the genetic distances between the cattle breeds and thereby find the most unique breeds with highest value for conservation (Cañón *et al.*, 2001). The Weitzman approach in breed diversity studies has been criticized for neglecting the within breed variation (e.g. Toro, 2006). The chicken diversity study (Hillel *et al.*, 2003) was accompanied by a cluster analysis about the composition of named breeds (Rosenberg *et al.*, 2001). This kind of study would set more comprehensive criteria for choosing populations for conservation.

The most recent technology is direct sequencing of individual genomes. This would provide new possibilities to reveal how domestication and selection have affected the genomes. The approach has been recently used in chicken (Rubin *et al.*, 2010).

QTL mapping has attracted many research groups. The research has been aimed at improving the understanding about quantitative genetics and at finding markers that could be used in enhancing the selection in traits subject to substantial non-genetic variation where conventional selection is rather inefficient. Thousands of QTL have been found across species, while very few cases have led to identification of the actual locus causing the variation. Many QTL-related patents have been released, though with rather thin practical usefulness. The animal breeding industry has therefore very enthusiastically switched to a new approach of using thousands of single nucleotide polymorphism (SNP) markers to find their individual effects among reliably tested individuals and thereby obtain predicted genetic values for marker typed newly born individuals (Meuwissen, Hayes and Goddard, 2001). The new strategy would accelerate breeding programmes with only a fraction of the costs of a conventional programme (Schaeffer, 2006). The successful application would require over 2000 reference individuals with accurately known genetic values (VanRaden *et al.*, 2009), feasible only in large-scale dairy cattle breeding. When individual operations at a country level in Europe are far from the required scale, this has triggered a new kind of collaboration between the countries and breeding companies.

Actors and networks

Networking in Europe has taken many forms. There is regional collaboration by the countries to respond to the FAO-coordinated work. Non-governmental organizations (NGOs) are functioning in different areas: research, general animal production, animal breeding, rare breeds, etc. The EU research framework programmes are facilitating lots of different types of collaboration across countries. There is also collaboration on harmonizing and delivering the data on breed diversity and state of conservation work in Europe.

Governmental organizations

The implementation of CBD is carried out by individual countries. The treaties, obligations, standards and recommendations accepted at an international level are developed and implemented within the countries by adjusting and completing the respective national strategies and policies, laws and statutes. Most of the European countries have national action plan to coordinate the inventory, breeding, conservation and capacity building topics for AnGR. Each country has networks for the management of genetic resources, including administration, breeding organizations, research and hobby societies. European National Coordinators for AnGR (NC) play a central role in the coordination of work at national level and NCs are organized in a European network.

European Regional Focal Point for Animal Genetic Resources

Europe plays an important role in the global programme for AnGR. Until 2007, it was the only region that had a common secretariat working towards a coordinated programme. It is called the European Regional Focal Point for Animal Genetic Resources (ERFP). The ERFP is the European implementation of global strategy of the FAO for the management of farm AnGR. ERFP is a communication platform managed by a secretariat and steering committee. It publishes information for the national coordinators and ensures the exchanges of information and experience between the different countries and the governmental and NGOs. When compared with the well-established networks in the PGR sector (ECP/GR – European Cooperative Programme for Crop Genetic Resources Network) and forestry (Euforgen – European Forest Genetic Resources Programme), there is clearly a need to further strengthen the European regional coordination on AnGR.

ERFP works with subregional organizations in order to reinforce the common approach in neighbouring countries having the same problems or needs. For example, the Nordic countries are collaborating in the area of AnGR. This includes research, breeding organizations and the joint work within the animal sector of the Nordic Genetic Resource Centre (NordGen). Such a close subregional collaboration is unique. It is based on common values, needs and goals and brings benefits in cost efficiency and increased critical mass. The NordGen animal sector has had working groups, for example, on sustainable management of AnGR (Woolliams *et al.*, 2005)

and the policy issues related to access and benefit sharing (Mäki-Tanila *et al.*, 2009).

ERFP has also established close working relationship with international NGOs such as Rare Breeds International (RBI), The SAVE Foundation (Safeguard for Agricultural Varieties in Europe), Danubian Alliance for Conservation of Genes in Animal Species (DAGENE) or the European Forum of Farm Animal Breeding (EFFAB). For all the scientific aspects, it receives help from the European Association of Animal Production Working Group on Animal Genetic Resources (EAAP WG-AGR). The ERFP does not create new structures but relies as far as possible on existing functional structures in the different countries. ERFP has recruited working groups to focus on regional or general questions on AnGR. An example of an outcome from such working groups has been the guidelines on cryopreservation (Hiemstra, 2003; Planchenault, 2003).

The ERFP has also supported a range of regional workshops organized by NCs. These workshops have looked at issues such as the practical and scientific aspects of the conservation of AnGR in individual countries, strategies for conservation, and use and training in various aspects of AnGR conservation.

The ERFP holds an annual meeting of NCs. The meeting is organized at the same location as the EAAP annual meeting to allow NCs to participate in the scientific sessions of EAAP, in which there is also a scientific session organized by the ERFP, relating to the scientific aspects of AnGR research and conservation.

Non-governmental organizations

In Europe, there is a variety of organizations and networks actively involved in AnGR management, representing different stakeholder groups (including animal breeding, conservation and research).

European Federation of Animal Science

The EAAP represents the professional interests of scientists, academics, professionals and producers, technicians, extension officers, government departments and farmer organizations. Its mission is to promote generation and dissemination of knowledge and views on animal science and production. It organizes annual meetings with several study commissions. An example is the Genetics Commission, which attracts highly qualified speakers often also from outside Europe. EAAP also established a specific – and in many ways pioneering – working group on AnGR as early as 1980 (Maijala *et al.*, 1984). EAAP recently started publishing a scientific journal *Animal*. There are also report-type publications appearing regularly on specific topics. Most of the funding to the EAAP organizations comes from national organizations within European countries, with major contributions from the national governments.

SAVE Foundation

The SAVE Foundation is the European umbrella organization for the safeguarding of agricultural varieties. Its mission is the conservation and promotion of genetic and historically important cultural variety in agricultural flora and fauna. Particular emphasis is placed on ensuring the survival of threatened breeds of farm animals and species of cultivated plants. SAVE Foundation links the work of NGOs throughout Europe.

European Forum of Farm Animal Breeding

The EFFAB is an independent European forum for farm animal reproduction and selection organizations (industry and farmer's cooperatives), including companies involved in related technologies. A number of animal breeders came together to form the group in Utrecht in 1995. Their first goal was to improve industry access to research and promote the technology transfer of research results within the biotechnology and agriculture research programmes of the European Commission. EFFAB is approaching funding bodies to enhance the positive image of animal breeding. Furthermore, it is promoting transparency, diversity and animal welfare in interacting with the media and the general public. Recently, EFFAB joined the group of NGOs working closely with FAO.

Research

Knowledge lies at the heart of the European Union's Lisbon Strategy to become the "most dynamic competitive knowledge-based economy in the world". The "knowledge triangle" – research, education and innovation – is a core factor in European efforts to meet the ambitious Lisbon goals. Numerous programmes, initiatives and support measures are carried out at EU level in support of knowledge. The Seventh Framework Programme (FP7) bundles all research-related EU initiatives together under a common goal and plays a crucial role in reaching the goals of growth, competitiveness and employment; along with a new competitiveness and innovation framework programme, education and training programmes, and structural and cohesion funds for regional convergence and competitiveness. It is also a key pillar for the European Research Area (ERA). The broad objectives of FP7 have been grouped into four categories: cooperation, ideas, people and capacities. For each type of objective, there is a specific programme corresponding to the main areas of EU research policy. All specific programmes work together to promote and encourage the creation of European centres of (scientific) excellence.

In the area of cooperation, for example, Erasmus Mundus is a cooperation and mobility programme in the field of higher education that aims to enhance the quality of European higher education and to promote dialogue and understanding between people and cultures through cooperation with third countries. The Erasmus Mundus

programme promotes collaboration between excellent universities within the EU. Also in the area of animal breeding and genetics, joint courses have been developed and funded by the EU (EM-ABG).

The EU lays special emphasis on funding research programmes. One of the themes is related to food agriculture and fisheries, and biotechnology. The funding strategy is carried out by programmes that operate periodically. The programmes support transnational cooperation in research, innovation delivery and policy support across the European Union, and beyond. The programme is promoting a European knowledge-based bio-economy by bringing together science, industry and other stakeholders, to exploit new and emerging research opportunities that address social, environmental and economic challenges. There are many types of research collaboration: networks of excellence, collaborative project (generic), large-scale integrating project, small- or medium-scale focused research project, support actions, coordination (or networking) actions and collaborative project for specific cooperation actions dedicated to international cooperation partner countries (SICA).

Research will be enabled for the sustainable production and management of biological resources (microbial, plants and animals) and will include "omics" technologies incorporating genomics, proteomics, metabolomics and converging technologies, and their integration within systems biology approaches, as well as the development of basic tools and technologies and relevant databases for variety identification within species groups. Sustainability and competitiveness are improved while safeguarding consumer health and decreasing environmental impacts in agriculture, horticulture, forestry, fisheries and aquaculture, at the same time taking into account climate change. Through the development of new technologies, a whole ecosystem approach will be addressed.

The topics, funded by FP7, have covered or are currently covering many areas in genetics, genomics, breeding and diversity of farm animals. Few examples are: QTL mapping, genomics applications, organic sustainable breeding of dairy cattle, breeding in low-input production, candidate genes for meat quality and fatness, sustainable use of reproduction technology, use of high performance computing, genetic strategies for controlling salmonellosis, breeding tools for mastitis resistance, animal disease genomics, improvement of robust dairy cattle, sheep health genetics, utilization of SNPs in commercial pig breeds, sequence tools for livestock genomes, characterization of pig breed diversity, genetic tools to mitigate environmental impact and diversity information system.

Monitoring and characterization

To monitor diversity in European farm animal breeds a European farm animal biodiversity system (EFABIS) was developed. The European EFABIS database connects data from a network of national biodiversity databases (EFABISnet). EFABIS is also linked directly to the global database hosted by the FAO. The development projects for the database have been funded by EU, and supported/initiated by EAAP and ERFP. The recent EFABISnet phase includes also a database tool for national cryopreservation banks.

Conclusions

In planning future strategies for AnGR conservation and use, it is useful to identify the major strengths, weaknesses, opportunities and threats. European countries have efficient breeding organizations. Many breeds have established herd books and the commercial breeding industry is leading in the world market. Furthermore, Europe has a successful tradition of scientific research, which has supported conservation, sustainable use and exploitation of farm animal genetic diversity. AI (artificial insemination) industry has in many countries supported the cryopreservation of local breeds.

For the coordination of the work, most European countries now have a national plan for AnGR covering inventories, breeding, conservation and capacity building. AnGR conservation and sustainable use can both directly and indirectly benefit from European policies; however, within the EU Commission the AnGR issues are dealt with by multibodies without a steering umbrella unit.

In many countries, the development of agriculture and livestock production has resulted in a specialized and intensive type of animal production. Local AnGR are, in the majority of cases, lower producers when compared with the mainstream breeds. The production gap will become larger with every generation, as new technologies such as genomic selection can only be used successfully in large populations. The change of the CAP and implementation and funding of rural development programmes may be beneficial for the maintenance of local breeds in a local context. Farmers should also benefit financially from other values of local breeds, e.g. environmental values. When subsidies are paid to keep local breed animals, it is important to integrate that into a serious development programme, driven by a network of farmers and a breed association.

European citizens in general have a strong awareness about the importance of biodiversity. An increasing demand for diversified products by consumers is an opportunity for development of breed-specific products (niche markets), including organic products, resulting in an added value for the farmers. Food chains are in very few hands, which makes it sometimes difficult for niche products to enter the market successfully.

Conservation and sustainable use of AnGR in Europe could benefit from further collaboration and exchange of knowledge and experiences across countries. The ERFP is a common forum for the coordinators of European

national programmes on AnGR. There are also many NGOs working for the animal sector in general animal production and the conservation of AnGR and in animal breeding in specific. These NGOs and networks are most relevant to raising awareness about the importance of values of AnGR and in enhancing activities that contribute to conservation and sustainable use of AnGR.

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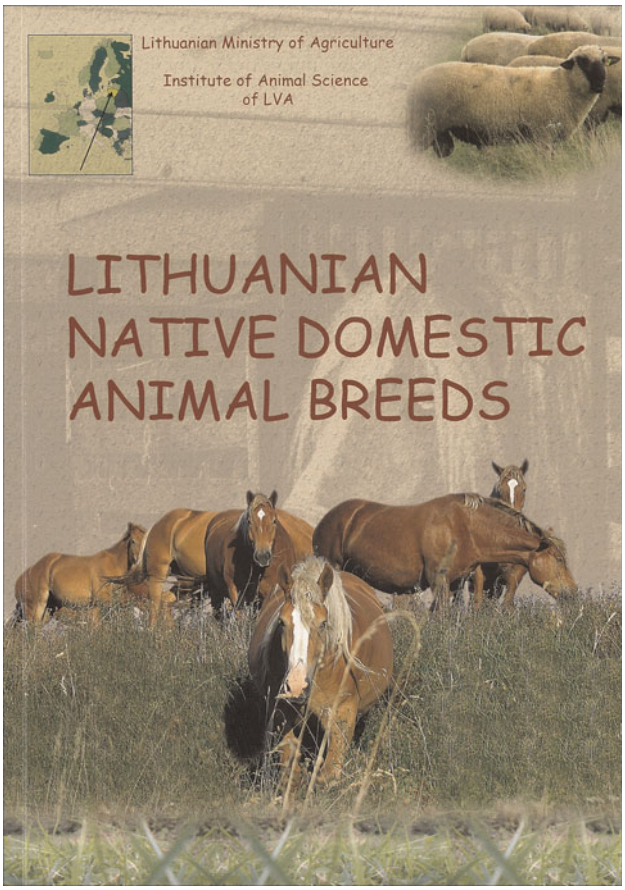
Animal Genetic Resources, 2010, 47, 137.

Recent Publication

Lithuanian native domestic animal breeds

Compiled by Rūta Šveistienė
Institute fo Animal Science of LVA, Baisogala, Radviliškis Distr., Lithuania
Published in 2007, 36 pp.
ISBN: 978-9955-676-73-7

doi:10.1017/S2078633610001074



This booklet provides an introduction to the eponymous animal genetic resources. A brief overview of the history of animal genetic resources management in Lithuania from the post-First World War period to recent times is followed by short descriptions and histories of individual breeds of horse, cattle, pigs, sheep, goat, goose, dog and bee. Several of these accounts describe factors that have driven native breeds towards extinction, and the steps that have been, or should be, taken to conserve them. The booklet is illustrated throughout with colour photographs.

Animal Genetic Resources, 2010, 47, 138–139.

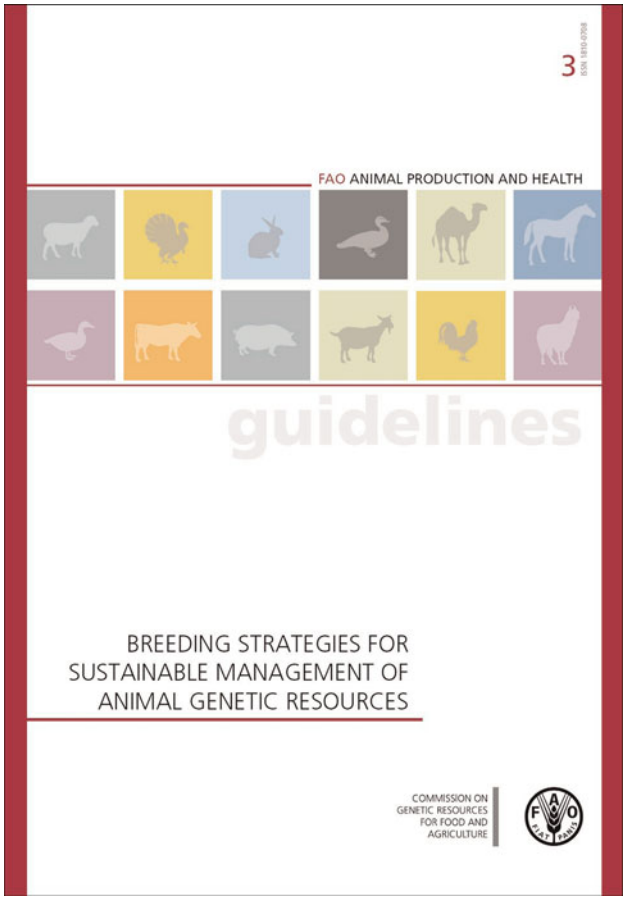
Recent Publication

FAO. 2010. Breeding strategies for sustainable management of animal genetic resources

FAO Animal Production and Health Guidelines. No. 3.
Rome, pp 155.
ISBN 978-92-5-106391-0.
Available at: http://www.fao.org/docrep/012/i1103e/i1103e00.htm (English version); http://www.fao.org/docrep/012/i1103s/i1103s.pdf (Spanish version)

doi:10.1017/S2078633610001086

The full potential of animal genetic resources is not being realized, particularly in developing countries, and it is recognized that there is a great need to improve the use and development of these resources. This is clearly stated in *The State of the World's Animal Genetic Resources for Food and Agriculture* and in the *Global Plan of Action for Animal Genetic Resources*, adopted by the International Technical Conference on Animal Genetic Resources for Food and Agriculture held in Interlaken, Switzerland, in September 2007, and subsequently endorsed by all FAO member countries. The *Breeding strategies for sustainable management of animal genetic resources*, prepared by FAO, are a contribution to meeting these needs. The specific objective of the guidelines is to assist countries to plan and develop effective genetic improvement programmes and to maximize the chances that these programmes will be sustained. The guidelines aim to address policy, operational and technical issues, and how these interplay to shape the outcomes of breeding strategies. Policy-makers and organizations involved in livestock development are the principal target audience. The guidelines adopt a broad scope in order to avoid fragmenting the topic and presenting policy, operational or technical matters in an unconnected way to different groups of users. A comprehensive approach is necessary because the lessons learned from livestock breeding in practice demonstrate that activities must be coordinated and integrated in time and space in order to achieve clarity of direction and efficiency of operation, and that the whole process must be underpinned by a sound understanding of technical issues. The initial sections of the guidelines take a national or regional perspective. Later sections become progressively more targeted towards breeding



organizations and those responsible for implementing specific breeding schemes, both straight-breeding and cross-breeding. Each section outlines a set of tasks that needs to be carried out in order to achieve the desired outcomes. Each of these tasks is further broken down into a series of actions. The last section of the guidelines deals with the evaluation of investment decisions and return on investment in genetic improvement.

The six sections of the guidelines are more-or-less stand-alone elements, and while knowledge of animal breeding theory and quantitative genetics is not a prerequisite for following the guidelines, such knowledge will certainly lead to more appreciation of the material discussed.

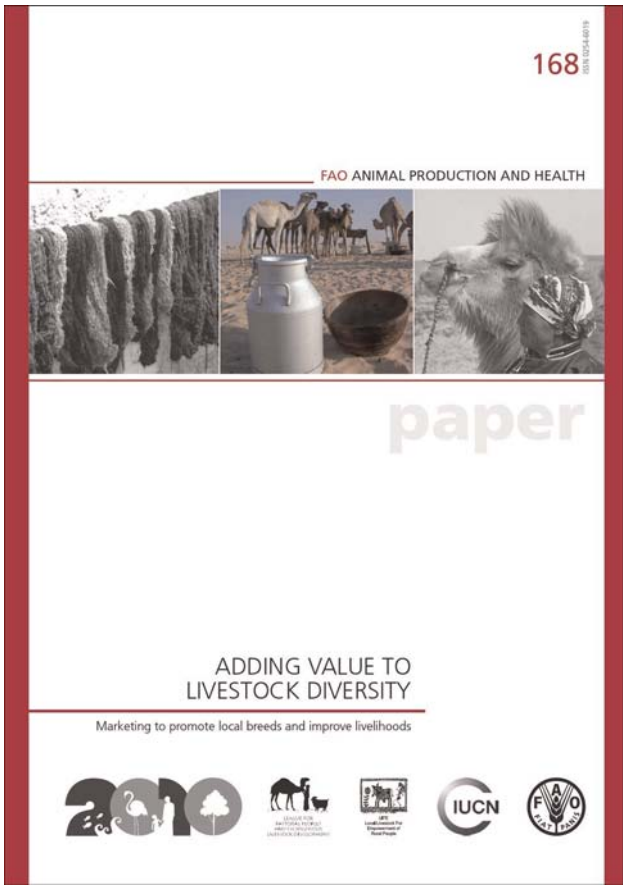
The guidelines include 48 boxes, which provide illustrations and case studies, 8 tables and 4 figures.

Recent Publication

LPP, LIFE Network, IUCN–WISP and FAO. 2010. Adding Value to Livestock Diversity-Marketing to promote local breeds and improve livelihoods

FAO Animal Production and Health Paper. No. 168.
Rome, pp 142.
ISBN 978-92-5-106453-5.
Available at: http://www.fao.org/docrep/012/i1283e/i1283e.pdf
(English version; French and Spanish in preparation)

doi:10.1017/S2078633610001098



Many local breeds and minor species are in decline because they cannot compete with high-yielding specialized breeds. Conserving these local breeds is important as many have unique traits, such as hardiness and disease resistance that are vital for the future of livestock production. One way to ensure the survival these breeds may be to sell their products in high-value specialized markets. This book presents eight examples of the use of such an approach. These case studies are grouped by type of product: (i) wool and cashmere; (ii) meat and hides; and (iii) milk. They cover a range of species (Bactrian camel, dromedaries, goats, and sheep) and seven countries in Africa, Asia and Latin America. The case studies are followed by a final section that analyses lessons learned. It shows how livestock-keeping communities have kept local breeds in use, while enabling the people who raise them to improve their livelihood.

While local breeds are suited to supplying niche markets – because of cultural factors and the unique characteristics of their products – some of these specificities (e.g. coloured wool) may hinder access to global mass markets. Such products need market development, diversification, market penetration and product development. The case studies describe various types of intervention that contribute to the addition of value – animal production, processing, and organizing and building value chains – with the main focus on processing and building value chains. The majority of the initiatives described involved a *champion* – a person or organization with a special interest in promoting the enterprise and making sure it worked. The book provides recommendations for those who are already in this business or who want to become involved. It makes nice reading with high degree of practicability.

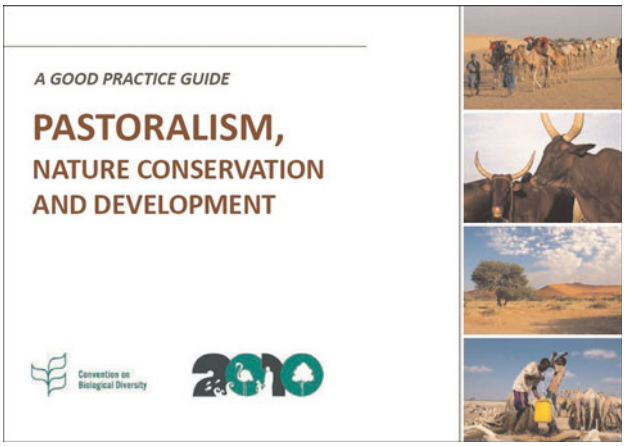
Animal Genetic Resources, 2010, 47, 141. © Food and Agriculture Organization of the United Nations, 2010

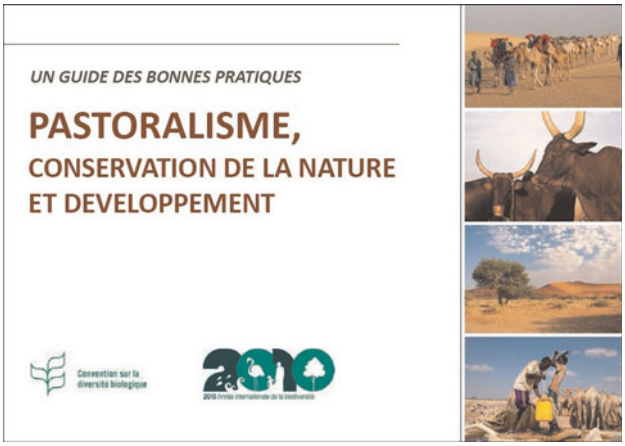
Recent Publication

Secretariat of the Convention on Biological Diversity. 2010. Pastoralism, Nature Conservation and Development: A Good Practice Guide

Montreal, 40+iii pages.
ISBN: 92-9225-162-7.
Also Available at: http://www.cbd.int/development/training/guides/ (in Arabic, English and French)

doi:10.1017/S2078633610001104





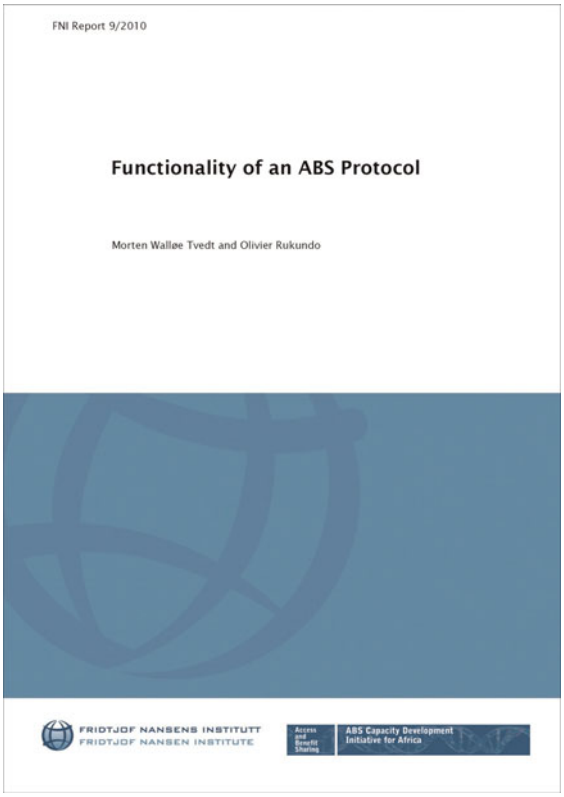
This guide addresses the linkages between pastoralism, biodiversity, development and poverty reduction. It aims to raise awareness of tools relevant to the pastoralism sector that have demonstrated benefits for biodiversity and for development. Readers wishing to make use of these tools are provided with numerous supplementary references and sources. The guide describes the role of pastoralism in the conservation and sustainable use of biodiversity in drylands, and the contribution of pastoralism to poverty reduction and development. It presents eight illustrative case studies involving different livestock species in different parts of the world. It highlights the role of public decision-makers and introduces them to policy considerations, management tools, market-based instruments and capacity-building methods that can help augment the social and environmental outcomes of pastoralism. The guide provides examples of good practice in the interface between pastoralism, poverty reduction and biodiversity. It aims to assist Parties to the Convention on Biological Diversity in establishing national and subnational policies, strategies, plans and projects for the development of pastoralism that consider poverty reduction and the conservation of biodiversity. A CD-ROM attached to the booklet sleeve includes a PDF version of the guide and a summary slide presentation that can be used during training sessions, workshops, strategic planning meetings, etc; users can prepare their own customized presentations by selecting and editing these slides. The guide is highly recommended as reading and training material for stakeholders concerned with pastoralism as a livestock production system, ecology and poverty alleviation.

Recent Publication

Morten Walløe Tvedt and Olivier Rukundo. 2010. Functionality of an ABS Protocol

FNI Report 9/2010, pp 25.
ISBN 978-82-7613-592-3-print version, 978-82-7613-593-0-online version Orders to: Fridtjof Nansen Institute, Postboks 326, N-1326 Lysaker, Norway. Tel: (47) 6711 1900, Fax: (47) 6711 1910 Email: post@fni.no; Also available at http://www.fni.no/doc&pdf/FNI-R0910.pdf.

doi:10.1017/S2078633610001116



This report is a contribution from the Fridtjof Nansen Institute (FNI), Norway, as part of a research project on access and benefit sharing (ABS) carried out in cooperation with the multi-donor ABS Capacity Development Initiative for Africa. The initiative is supported by the Directorate-General for International Cooperation (DGIS) of the Dutch Ministry of Foreign Affairs, the Norwegian Ministry of Foreign Affairs, the German Federal Ministry for Economic Cooperation and Development (BMZ) and the Institut de l'énergie et de l'environnement de la Francophonie (IEPF) and carried out in partnership with the United Nations Environment Programme (UNEP) and the Secretariat of the Convention on Biological Diversity (CBD). The implementation of the Initiative is commissioned by BMZ to the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

The report is an analysis of the draft Protocol on ABS which came into being after the deliberations of the resumed Ninth Meeting of the Ad Hoc Open-ended Working Group on ABS which took place in July 2010 in Montreal. The report suggests that, as it stands now, the draft protocol contains few elements that clearly serve to create incentives for private or public users to enter into ABS contracts and share benefits that may be created therefrom.

For this reason, the report examines a range of contentious issues where disagreement has prevailed among negotiating parties and regional groups, with a view to providing a legal analysis of the state of the negotiations and with the hope that this can contribute to a better technical understanding of some of the issues at the core of the negotiations and assist in the preparations for the last round of negotiations before the adoption of the protocol. The report endeavours to provide perspectives on where negotiations stand at this juncture. It aims to offer some thoughts as to how certain provisions of the draft protocol can be dealt with in view of ensuring that the protocol will effectively contribute to the fulfillment of the third objective of the CBD. The provisions of the protocol, as they currently stand, will not be conducive to the fair and equitable sharing of benefits unless the wording can be further clarified to ensure that the protocol will be implemented into national legislations and that it will in fact have legal effect on users of genetic resources. Particular attention is given to issues related to the scope, utilization, and relationship of the prospective protocol with other international instruments.

The functionality of the protocol rests on finding an adequate balance between two imperatives. On the one hand, developing countries often advocate strong compliance mechanisms coupled with clear benefit sharing obligations. This is essentially based on a view that provider-side law and contractual provisions are currently insufficient in dealing with misappropriation and/or misuse. On the other hand, it is not enough to require user-side measures: the protocol must also make those measures reasonable from the perspective of the provider side.

Among issues highlighted in the report are retroactivity and exemptions from the scope of the protocol (e.g. human genetic resources, geographical origin and possibly pathogens). As the CBD has been a binding convention since 1993, states have been obliged to impose benefit-sharing measures for almost 18 years now. The key question with regard to the retroactivity of the protocol is whether it introduces new rules or provides clarification of existing obligations.

The report with its legal tint is an advised reading for CBD negotiators and country delegates.

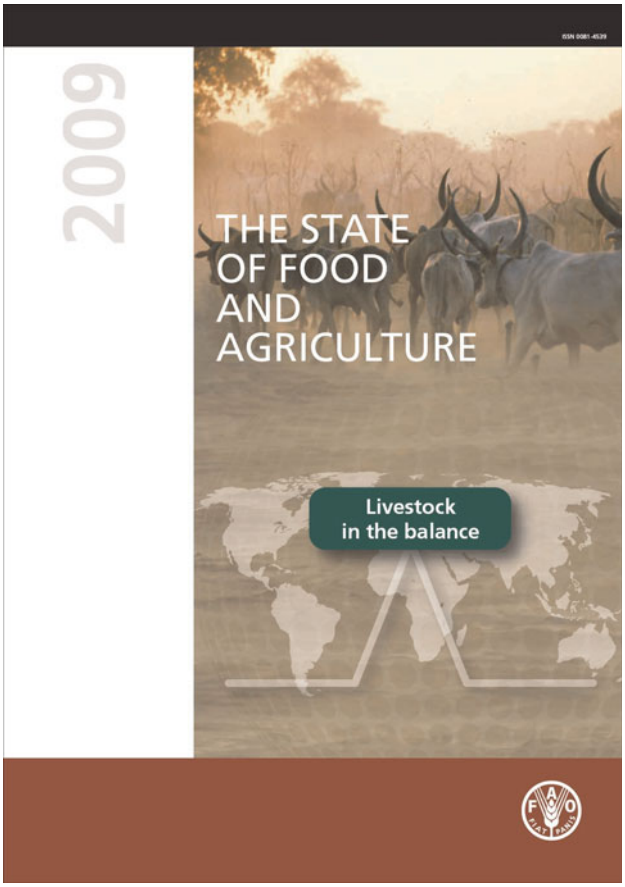
Animal Genetic Resources, 2010, 47, 143–144.

Recent Publication

FAO. 2009. The State Of Food And Agriculture 2009 – Livestock in the balance

ISBN 978-92-5-106215-9;
available at: http://www.fao.org/publications/sofa/en/ (in Arabic, Chinese, English, French, Russian and Spanish)

doi:10.1017/S2078633610001128



The latest edition of FAO's flagship publication focuses on livestock and argues that major investments and research efforts, coupled with robust governance are required to ensure that the world's livestock sector responds to a growing demand for animal products and at the same time contributes to poverty reduction, food security, environmental sustainability and human health. The report stresses that livestock is essential to the livelihoods of around one billion poor people. Livestock provides income, high-quality food, fuel, draught power, building material and fertilizer, thus contributing to food security and nutrition. For many small-scale farmers and pastoralists, livestock also provides an important safety net in times of need.

The livestock sector is one of the fastest growing parts of the agricultural economy. Livestock contributes 40 percent of the global value of agricultural production. Globally, livestock contributes 15 percent of total food energy and 25 percent of dietary protein. Products from livestock provide essential micronutrients that are not easily obtained from other plant food products. Rising incomes, population growth and urbanization are the driving forces behind a growing demand for meat products in developing countries. To meet rising demand, global annual meat production is expected to expand from 228 tonnes currently to 463 million tonnes by 2050, with the cattle population estimated to grow from 1.5 billion to 2.6 billion and that of goats and sheep from 1.7 billion to 2.7 billion.

Strong demand for animal food products offers significant opportunities for livestock to contribute to economic growth and poverty reduction. But many smallholders are facing challenges in remaining competitive with larger, more intensive production systems. The report warns that "a widening gulf is emerging between those who can take advantage of growing demand for livestock products and those who cannot." Smallholders should be supported in taking advantage of the opportunities provided by an expanding livestock sector and in managing the risks associated with increasing competition. Broader rural development strategies creating off-farm jobs should help those that may be unable to adapt and compete in a rapidly modernizing sector. The report also highlights the need for "Policy makers to recognize and protect livestock's safety-net function for the very poor".

There is a need to enhance the efficiency of natural-resource use in the sector and to reduce the environmental footprint of livestock production. The must be to ensure that continued growth in livestock production does not create undue pressure on ecosystems, biodiversity, land and forest resources and water quality and does not contribute to global warming. While some countries have made progress in reducing pollution and deforestation associated with livestock production, many more require appropriate policies and enforcement capacity. Market-based policies, such as taxes and fees for natural-resource use or payments for environmental services, would encourage producers to ensure that livestock production is carried out in a sustainable way. Livestock can play an important role in both adapting to climate change and mitigating its effects on human welfare. To realize the sector's potential to contribute to climate change mitigation and adaptation based on enhanced capacities to monitor, report and verify emissions from the livestock production new technologies will need to be developed.

Animal diseases pose systemic risks that must be addressed. Since new pathogenic agents will continue to emerge, investments in national animal-health and food safety infrastructure are required. Poor livestock keepers need to be more engaged in disease-control efforts.

As FAO Director-General Jacques Diouf writes in the foreword to the report: "The rapid transition of the livestock sector has been taking place in an institutional void … The issue of governance is central. Identifying and defining the appropriate role of government, in its broadest sense, is the cornerstone on which future development of the livestock sector must build." Efforts are needed to ensure that this rapidly growing sector contributes fully to food security and poverty reduction, and that we move – in Dr Diouf's words – "towards a more responsible livestock sector".

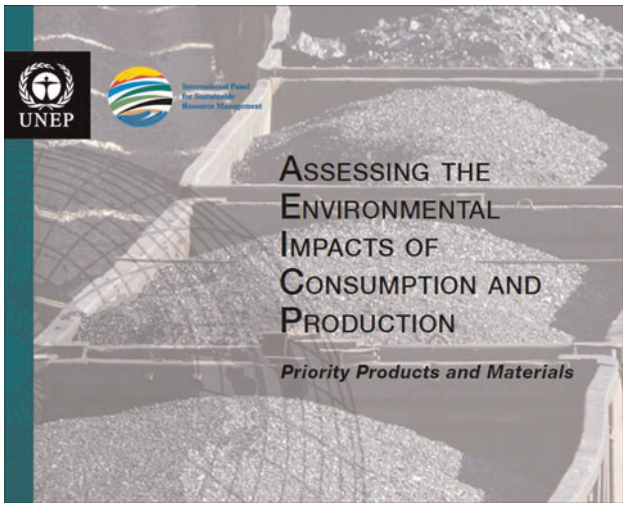
Animal Genetic Resources, 2010, 47, 145.

Recent Publication

Assessing the environmental impacts of consumption and production: priority products and materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management

E. Hertwich, E. van der Voet, S. Suh, A. Tukker, M. Huijbregts, P. Kazmierczyk, M. Lenzen, J. McNeely and Y. Moriguchi.
United Nations Environment Programme,
Published in 2010, pp. 108.
ISBN: 978-92-807-3084-5.
Available at: http://www.unep.org/resourcepanel/documents/pdf/PriorityProductsAndMaterials_Report_Full.pdf

doi:10.1017/S207863361000113X



Habitat change, overexploitation of renewable resources, climate change, and particulate-matter emissions are among the most important environmental problems. These lead to biodiversity losses and negatively affect health (ecological, animal and human). This report, prepared by the International Panel for Sustainable Resource Management, assesses environmental and resource impacts of production and consumption. It focuses not on the effects of environmental pressure (commonly tied to the extraction and transformation of materials and energy) but on its causes. It describes pressures as consequences of economic activities pursued to satisfy consumption. The report investigates the production–materials–consumption complex. It addresses this fundamental question in two main steps: a review of work assessing the importance of observed pressures and impacts on the Earth's natural system (usually divided into ecological health, human health, and resources provision capability) is followed by an investigation of the causation of these pressures by different economic activities. This work focuses on three main areas: industrial production, i.e. which production processes contribute most to pressures and impacts; final consumption, i.e. which products and consumption categories have the greatest impacts across their life-cycles; and material use, i.e. which materials have the greatest impacts across their life-cycles.

A fundamental question faced by governments worldwide is how different economic activities influence the use of natural resources and the generation of pollution. The report analyses the relative importance of industries (including agriculture), consumption categories and materials across the world and offers a detailed problem description and analysis of the causation of environmental pressures, thus contributing to the knowledge needed for reducing environmental impacts. It indicates where improvements are necessary, but it does not describe what changes are required or how much they will contribute to improvements.

From available studies and the panel's own analyses, the report concludes that agriculture and food consumption, along with the use of fossil energy carriers, are among the most important drivers of environmental pressures. It further concludes that impacts related to these activities are unlikely to be reduced, but rather enhanced, in a business-as-usual scenario. The study shows that CO_2 emissions are highly correlated with income. Hence, population and economic growth will lead to higher impacts, unless patterns of production and consumption can be changed.

There is a tendency in the report to depict the animal as a culprit for environmental degradation. Examples include the following generalization: "A substantial reduction of environmental impacts would only be possible with a substantial worldwide diet change, away from animal products." While this might be true in many situations, a distinction should be made between livestock production systems where the animal is an enhancing environmental factor and systems where animals may be a detrimental factor; and between countries – the human populations in most developing countries still suffer from diets deficient in the animal protein needed for proper mental and body development, especially among growing children, while other countries face problems associated with the negative effects that excessive consumption of animal products can have on human health.

The report is mainly written to help decision-makers identify priorities from a resources life-cycle perspective.

Animal Genetic Resources, 2010, 47, 147–149. © Food and Agriculture Organization of the United Nations, 2010
doi:10.1017/S2078633610001141

Instructions for contributors

Animal Genetic Resources is a trilingual journal, published three times per year online (http://journals.cambridge.org/AGR) and in print. Main papers are published in English, French or Spanish, with a summary in all three languages. The journal has been published since 1983, and all back issues are available at http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=−1,refcat_50000044.

The journal encourages submissions from all over the world. Authors who are not fluent in any of the three accepted languages are encouraged to seek assistance in this regard before submitting their manuscripts.

Mission statement

The journal provides an international forum for the publication of papers related to the management of animal genetic resources for food and agriculture (AnGR). It covers the following areas: phenotypic and molecular characterization; surveying and monitoring; development (genetic improvement); sustainable use; conservation; capacity-building in livestock keeper and pastoralist communities; and policies and institutions.

The editors welcome all papers addressing the topics above. Papers related to breeds and technologies contributing to the sustainable management of the world's medium-to-low input production systems, which account for the largest area of land involved in livestock production and for a major part of production from livestock, are of a particular interest.

The journal supports the implementation of the Global Plan of Action for Animal Genetic Resources, the internationally agreed framework for the management of AnGR and the Convention on Biological Diversity.

Disclaimer

Views expressed in the papers published in Animal Genetic Resources represent the opinions of the author(s) and do not necessarily reflect the policies of FAO or the views of the editors or the institutions with which the authors are affiliated.

Peer review

Manuscripts submitted for publication in Animal Genetic Resources undergo full peer review by two referees. The suitability of manuscripts is judged by the reviewers and editors, and the editors' decision on a paper is final.

Categories of papers

Research papers – Findings of work related to the management of AnGR will be considered for publication in AGRI. Authors are encouraged to include relevant high-quality photographs in their manuscripts. If photographs illustrate animals, they should be shown in the primary production environment to which they are adapted.

Review papers – Unsolicited papers reviewing country-level, regional or global developments in one or more aspects of AnGR management will be considered for publication. These papers may include state-of-the-art reviews of specific fields in AnGR management.

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- book reviews or proposals
- conclusions and recommendations arising from relevant meetings, workshops and conferences
- announcements of training courses and major national, regional and international events

Originality and copyright

To be considered for publication in the journal, a manuscript must not have been published previously, nor be under review for publication elsewhere. (Previously published figures may be used sparingly in reviews, provided that permission has been obtained as appropriate.) Prior to publication, an authorization and copyright transfer agreement form must be signed and returned to the publishers by the lead or corresponding author of a manuscript (corresponding authors sign on behalf of any co-authors). The form will be sent to the lead or corresponding author together with the proof of the paper for publication.

Authorship

Papers with multiple authors are reviewed with the assumption that all authors have contributed materially to the research reported, have approved the submitted manuscript, and concur with its submission. A contribution includes the conception and design of the project, the performance of experiments and/or the analysis and interpretation of data. Authors should have made a substantial intellectual contribution to the drafting or critical revision of the manuscript.

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All manuscripts must be submitted online at http://journals.cambridge.org/AGR. No page charges are required from the author.

Receipt of your manuscript will be acknowledged, a manuscript reference number assigned and the manuscript will be sent out for review. You should quote your manuscript reference number in all subsequent correspondence.

The following instructions must be followed carefully (see *Manuscript preparation and style* for further details):

- Manuscripts may be submitted in English, French or Spanish. If your manuscript is written in French or Spanish, it should include a summary and keywords in that language as well as in English. All published articles will feature a summary in English, French and Spanish. It would be appreciated if, wherever possible, authors could supply a summary in all three languages, as this reduces the need for translating services and therefore expedites processing of the manuscript.
- The preferred file format for submission is Microsoft Word. Word Perfect or other word-processor files are not acceptable. Tables should be included within the same file but at the end of the document. Placeholders should be used within the text to indicate their positioning.
- Figures must be submitted as separate files, and at to-be-published resolution (see Manuscript preparation and style for further details).
- A cover letter should be provided as a separate file. The letter should indicate the category under which the manuscript is submitted (see Appendix 1) and provide the details of the corresponding author (telephone number, fax number and e-mail address).
- Filenames should indicate the name of the first author of the paper, either in full or abbreviated.
- Printed copies of the manuscript, tables and figures are not required and should not be sent.

Please note that correspondence regarding submitted and revised manuscripts will take place with the corresponding author only.

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The manuscript should be formatted with line spacing set to "double". Pages should be numbered sequentially beginning with the title page. Margins should be at least 2.5 cm on all sides. The font should be set to Arial.

Authors and affiliations – Names and affiliations of authors should be presented as follows:

E.C. Quispe[1], T.C. Rodríguez[2], L.R. Iñiguez[3] and J.P. Mueller[4]

[1]Universidad Nacional de Huancavelica, Huancavelica, Perú; [2]Universidad Mayor de San Andrés, La Paz, Bolivia; [3]Cochabamba, Bolivia; [4]Instituto Nacional de Tecnología Agropecuaria, Bariloche, Argentina

Correspondence to: E.C. Quispe, Universidad Nacional de Huancavelica, Huancavelica, Perú. E-mail: edgarquispe62@yahoo.com

A ***Running Head*** of up to 50 characters should be provided on the title page.

The ***Summary*** should be unstructured (i.e., no sub-headings) but must provide the reader with a self-contained summary of the paper. It should include a brief introduction to the paper, the method, the key findings and the conclusions. The summary should be no longer than 210 words in English and 250 words in French and Spanish. A list of three to five keywords or terms for indexing should follow the summary and be separated by commas. The summary and keywords should be provided in the same language as the manuscript as well as in English.

The ***Body of the manuscript*** should begin on page 3 and a new page should be used for the References. The lines of text must be numbered and the manuscript structured with consecutively numbered headers and sub-headers (e.g. 1., 1.1, 1.1.1 etc). However, it is important to *avoid cross-referencing using these numbers*, as the editorial office will remove numbering and apply heading styles in the final version.

Research papers should additionally include the following headers: ***Materials and Methods***; ***Results***; ***Discussion***; ***Conclusions***.

The ***Maximum length*** of the body of the manuscript should not exceed 10 journal pages (approx. 8 500 words). Short communications should not exceed 1 journal page (approx. 750 words or, when an image is included, 550 words).

Tables should be numbered consecutively as they are cited in the text (Table 1, 2 etc.). Each table should be on a separate page (at the end of the document) with the number and heading above and any notes below the table.

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Acknowledgements

In this section authors should acknowledge any support from granting agencies and other sources for the work reported in their paper. The contribution of individuals who assisted with the research but are not included as authors of the paper may also be acknowledged in this section.

The Acknowledgements should be placed after the main body of the text before the references. If there are no Acknowledgements, the title should be inserted followed by "None".

Statement of interest

A conflict of interest exists when an author has interests that might inappropriately influence his or her judgement, even if that judgement is not influenced. Because of this, authors must disclose potentially conflicting interests so that others can make judgements about such effects. At the time of manuscript submission, authors should disclose any financial arrangements or connections they may have that are pertinent to the submitted manuscript and that may be perceived as potentially biasing their paper. Non-financial interests that could be

relevant in this context should also be disclosed. If no relevant interests exist, this should be stated. This requirement applies to all the authors of a paper and to all categories of papers.

References

Every reference cited in the text should be included in the reference list and every entry in the reference list should have been mentioned in the text at least once. References should be ordered first alphabetically by the first author's surname, and then by year.

Examples:

1 *Reference in a periodical*:
Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10: 53–64.

2 *When there is more than one author*:
Matos, C.A.P., Thomas, D.L., Gianola, D., Tempelman, R.J. & Young, L.D. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and non-linear models: 1. Estimation of genetic parameters, *Journal of Animal Science* 75: 76–87.

3 *For a book or an* ad hoc *publication, e.g., reports, theses*:
FAO, 2007. Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration. Food and Agriculture Organization of the United Nations, Rome, Italy (available at http://www.fao.org/docrep/010/a1404e/a1404e00.htm).
van der Werf, J., Graser, H-U., Frankham, R. & Gondro, C. (eds.) 2009. Adaptation and fitness in animal populations. evolutionary and breeding perspectives on genetic resources management. Springer.

4 *For an article in the proceedings of a meeting*:
Abad, M., Arrigo, J., Gibbons, A., Lanari, M.R., Morris, G. & Taddeo, H. 2002. Breeding scheme for Angora goat production in North Patagonia. Proceedings 7th World Congress on Genetics Applied to Livestock Production, 19-23 August 2002, Montpellier, France, 12–14.

5 *Information hosted on a web site*:
FAO. 2010. Domestic Animal Diversity Information System, http://www.fao.org/dad-is/, Food and Agriculture Organization of the United Nations, Rome, Italy.

For a work that has been accepted for publication but not yet published, "In press" should be written in place of the year of publication. Do not insert an expected year of publication.

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The online platform gives authors the opportunity to include data that would be impossible or impractical to include in the printed version. Authors may include tables and figures as well as data such as videos, 3-D structures/images, extensive datasets and any other supplementary material not suitable for print duplication. All supplementary material must be submitted with the original manuscript. Supplementary data should be referred to in the text with the prefix "S" (e.g. Supplementary Table S1, Supplementary Figure S1). Supplementary files will not be copyedited but will be published as supplied. The electronic publication of this material needs to be approved by the editors. The manuscript must be able to stand alone without the supplementary material (for the benefit of readers with access to the hard copy only).

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The publisher reserves the right to copyedit manuscripts to ensure that grammar and spelling are consistent with the style of the journal. The corresponding author will receive page proofs for final proofreading. These should be checked and returned within two days of receipt. The publisher reserves the right to charge authors for excessive correction of non-typographical errors.

Animal Genetic Resources, 2010, 47, 151–153. © Food and Agriculture Organization of the United Nations, 2010
doi:10.1017/S2078633610001153

Instructions pour les auteurs

Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales est un journal trilingue, publié trois fois par an en ligne (http://journals.cambridge.org/AGR) et en version imprimée. Les articles principaux sont publiés en anglais, français ou espagnol avec un résumé dans les trois langues. Le journal est publié depuis 1983 et tous les anciens numéros sont disponibles à l'adresse électronique http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,refcat_50000044.

On encourage la présentation d'articles provenant du monde entier à publier dans le journal. Les auteurs qui ne parlent aucune des trois langues admises sont encouragés à chercher de l'aide à cet égard avant de présenter leurs manuscrits.

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Le journal fait office de forum international pour la publication d'articles concernant la gestion des ressources zoogénétiques pour l'alimentation et l'agriculture. Il aborde en particulier les thèmes suivants: la caractérisation phénotypique et moléculaire; les enquêtes et le suivi; la mise en valeur (amélioration génétique); l'utilisation durable; la conservation; le renforcement des capacités au sein des communautés d'éleveurs et de pasteurs; et les politiques et les institutions.

Les éditeurs accueillent favorablement tous les articles abordant les thèmes indiqués ci-dessus. Un intérêt particulier sera attribué aux articles concernant les races et les technologies en faveur de la gestion durable des systèmes de production extensive ou semi-intensive dans le monde, qui représentent la plus grande partie des terres consacrées à l'élevage et une partie considérable de la production provenant de l'élevage.

Le journal soutient la mise en œuvre du Plan d'action mondial pour les ressources zoogénétiques, le cadre internationalement convenu en matière de gestion des ressources animales et la Convention sur la diversité biologique.

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Les opinions exprimées dans les articles publiés dans Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales sont celles du/des auteur(s) et ne reflètent pas nécessairement les politiques de la FAO ou les opinions des éditeurs ou des institutions pour lesquelles ils travaillent.

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Deux experts s'occuperont de la révision complète des manuscrits présentés pour la publication dans Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales. L'opportunité ou non de publier un manuscrit sera jugée par les réviseurs et par les éditeurs, et la décision finale sur l'article appartient aux éditeurs.

Types d'articles

Articles de recherche – Seront prises en considération pour leur publication sur AGR les études sur la gestion des ressources animales. On encourage les auteurs à envoyer des photographies de haute qualité avec les manuscrits. S'il s'agit de photographies d'animaux, il faudra montrer les races en question dans leur milieu naturel de production.

Révisions – Occasionnellement, des articles contenant une révision aux niveaux national, régional ou mondial des développements d'un ou de plusieurs aspects se rapportant à la gestion des ressources animales seront pris en considération. Ces articles pourront inclure les mises à jour des différents domaines de la gestion des ressources animales.

Articles spécifiques – Ponctuellement, des articles sur des thèmes spécifiques pourront être demandés pour la publication lorsque les éditeurs le jugeront nécessaire.

Autre matériel pour publication – On encourage les lecteurs à envoyer par courrier électronique à l'adresse AnGR-Journal@fao.org:

- la révision ou la proposition de livres
- les conclusions et les recommandations résultant de réunions, d'ateliers et de conférences importants
- les informations sur des cours de formation et sur les principaux événements régionaux, nationaux et internationaux.

Originalité et droits d'auteur

Pour que le manuscrit soit considéré pour la publication dans le journal, il faut qu'il n'ait pas été publié auparavant, ni qu'il soit en cours de révision pour la publication dans d'autres ouvrages. (Les chiffres publiés auparavant peuvent s'utiliser avec parcimonie dans les révisions, à condition d'en avoir obtenu l'autorisation.) Avant la publication, il faut que l'auteur principal du manuscrit signe et renvoie aux éditeurs le formulaire d'autorisation et d'accord de transfert des droits d'auteur (les auteurs principaux signent au nom de tous les co-auteurs). Le formulaire sera envoyé à l'auteur principal avec l'épreuve de l'article pour la publication.

Paternité

Les articles écrits par plusieurs auteurs sont révisés en présumant que tous les auteurs ont matériellement participé à la recherche signalée, ont approuvé le manuscrit présenté et approuvent sa présentation. Leur contribution comprend la conception et la création du projet, la performance d'expériences et/ou l'analyse et l'interprétation des données. Les auteurs devront avoir apporté une contribution intellectuelle considérable à la rédaction et à la révision critique du manuscrit.

Présentation du manuscrit

Tous les manuscrits seront présentés en ligne à l'adresse électronique http://journals.cambridge.org/AGR. Aucune charge par page ne sera requise de l'auteur.

On accusera réception du manuscrit, on attribuera un numéro de référence et le manuscrit sera envoyé pour révision. Vous devrez toujours indiquer le numéro de référence de votre manuscrit dans toute correspondance ultérieure.

Il faut suivre avec attention les instructions ci-après (pour de plus amples détails, voir *Préparation et style du manuscrit).*

- Les manuscrits se présenteront en anglais, français ou espagnol. Si votre manuscrit est en français ou en espagnol, il faudra ajouter un résumé et les mots clés dans cette langue ainsi qu'en anglais. On ajoutera à tous les articles publiés un résumé en anglais, français et espagnol. On appréciera si, dans la mesure du possible, les auteurs fournissent un résumé dans les trois langues, car les services de traduction seraient ainsi réduits et le traitement du manuscrit serait par conséquent plus rapide.
- Le format de fichier préféré pour la présentation est Microsoft Word. Word Perfect ou d'autres fichiers de traitement de texte ne sont pas acceptés. Les tableaux seront inclus au même fichier, mais à la fin du document. Les paramètres fictifs seront utilisés dans le texte pour indiquer leur positionnement.
- Les figures se présenteront en tant que fichiers séparés et en résolution publiable (pour de plus amples détails voir *Préparation et style du manuscrit*).
- Une lettre d'envoi sera envoyée dans un fichier séparé. La lettre signalera la catégorie d'appartenance du manuscrit (voir annexe 1) et fournira des informations sur l'auteur principal (numéro de téléphone, de télécopieur et adresse électronique).
- Les fichiers indiqueront le nom de l'auteur principal de l'article, soit en entier soit abrégé.
- Les copies imprimées du manuscrit, des tableaux et des figures ne sont pas requises et ne devront pas être envoyées.

Veuillez noter que la correspondance relative aux manuscrits présentés et révisés se fera uniquement avec l'auteur principal.

Préparation et style du manuscrit

Les manuscrits se présenteront à «double» interligne. Toutes les pages seront numérotées à commencer de la page du titre. Les marges seront d'au moins 2,5 cm pour tous les côtés. La police de caractère sera Arial.

Auteurs et institutions pour lesquelles ils travaillent – Les noms des auteurs et les institutions pour lesquelles ils travaillent se présenteront comme indiqué ci-après:

E.C. Quispe[1], T.C. Rodríguez[2], L.R. Iñiguez[3] et J.P. Mueller[4]

[1]Universidad Nacional de Huancavelica, Huancavelica, Perú; [2]Universidad Mayor de San Andrés, La Paz, Bolivia; [3]Cochabamba, Bolivia; [4]Instituto Nacional de Tecnología Agropecuaria, Bariloche, Argentina

Correspondance à envoyer à: E.C. Quispe, Universidad Nacional de Huancavelica, Huancavelica, Perú. Adresse électronique: edgarquispe62@yahoo.com

Sur la première page du manuscrit, on indiquera le ***titre de l'article*** qui ne devra pas dépasser les 50 caractères.

Le ***résumé*** ne sera pas structuré (c'est-à-dire, sans sous-titres), mais devra fournir au lecteur une brève description de l'article. Il inclura une introduction succincte à l'article, la méthode utilisée, les résultats principaux et les conclusions. Le résumé ne dépassera pas les 210 mots en anglais et les 250 mots en français et en espagnol. Une liste de mots clés ou de termes (entre trois et cinq) pour le sommaire suivra le résumé et les mots-clés seront séparés par des virgules. Le résumé et les mots-clés se présenteront dans la même langue du manuscrit ainsi qu'en anglais.

Le ***corps du manuscrit*** commencera à la page 3 et une nouvelle page sera utilisée pour les références. Les lignes du texte seront numérotées, le manuscrit sera structuré et tous les titres et les sous-titres seront numérotés (par exemple, 1, 1.1, 1.1.1, etc.). Il est toutefois important *d'éviter les références croisées avec ces numéros* car le bureau d'édition enlèvera la numérotation et appliquera des styles de titre dans la version finale.

Les articles de recherche devront en outre inclure les titres suivants: ***Matériels et méthodes; Résultats; Débat; Conclusions.***

La ***longueur maximale*** du corps du manuscrit ne dépassera pas les 10 pages du journal (environ 8 500 mots). Les communications brèves ne dépasseront pas 1 page (environ 750 mots ou, s'il y a également une image, 550 mots).

Les ***tableaux*** seront tous numérotés en suivant l'ordre d'apparition dans le texte (tableau 1, 2 etc.). Chaque tableau sera sur une page séparée (à la fin du document) avec le numéro et le titre au-dessus du tableau et d'éventuelles notes au-dessous.

Les ***figures*** seront toutes numérotées en suivant l'ordre d'apparition dans le texte (figure 1, 2 etc.). Il faudra écrire les lettres des parties a, b, c, etc. en italique et prévoir des légendes pour chaque figure. Les figures se présenteront, si possible, dans un fichier TIFF ou EPS, de préférence dans la taille approximative à utiliser pour la reproduction. Les illustrations graphiques seront fournies en noir et blanc avec une résolution de 1 200 ppp; les artwork combinaisons (ligne/ton) avec un résolution de 800 ppp; les illustrations en demi-ton noir et blanc seront sauvegardées en mode «niveau de gris» avec une résolution de 300 ppp; les illustrations en demi-teinte de couleurs seront enregistrées en mode CMJN avec une résolution de 400 ppp. Il faudra obtenir toutes les autorisations nécessaires.

Abréviations et unités SI – L'utilisation des abréviations, à part celles qui sont largement employées, est vivement déconseillée. Elles ne seront utilisées que si elles améliorent la compréhension du manuscrit. Les sigles s'écriront en entier la première fois qu'elles sont employées. Il faudra utiliser les unités du système métrique (SI).

Remerciements

Dans cette section, les auteurs remercieront pour tout appui reçu des institutions et d'autres sources de soutien pour le travail inscrit dans leur article. On peut ajouter également dans cette section la contribution d'autres particuliers ayant aidé dans le travail de recherche, mais n'étant pas inclus en tant qu'auteurs.

Les remerciements seront placés après le corps principal du texte avant les références. En cas d'absence de remerciements, le titre sera toutefois écrit et suivi par l'indication «aucun remerciement».

Déclaration d'intérêts

On est en présence d'un conflit d'intérêts lorsqu'un auteur a des intérêts qui pourraient influencer de façon inappropriée son jugement, même si ce jugement n'est pas en fait influencé. Pour cette raison, les auteurs doivent révéler les conflits d'intérêts potentiels pour que d'autres puissent juger de ces effets. Au moment de la présentation du manuscrit, les auteurs révéleront tout arrangement ou rapport financier pertinent avec le manuscrit présenté et qui pourrait être perçu comme pouvant porter un préjudice potentiel à l'article. Les auteurs révéleront également les intérêts non financiers qui pourraient être pertinents dans ce contexte. Il faudra également déclarer l'absence d'intérêts pertinents. Cette obligation s'applique à tous les auteurs d'un article et à toutes les catégories d'articles.

Références

Toute référence présente dans le texte devra apparaître sur la liste des références, et chaque entrée de la liste aura été citée au moins une fois dans le texte. Les références iront en ordre alphabétique du nom de l'auteur, suivi de l'année.

Exemples:

1 *Référence sur une revue:*
Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10: 53–64.

2 *Lorsqu'il s'agit de plus d'un auteur*:
Matos, C.A.P., Thomas, D.L., Gianola, D., Tempelman, R. J. et Young, L.D. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and non-linear models: 1. Estimation of genetic parameters, *Journal of Animal Science* 75: 76–87.

3 *Dans le cas d'un livre ou d'une publication ad hoc, par exemple, un rapport, une thèse:*
FAO, 2007. Plan mondial d'action pour les ressources zoogénétiques et la Déclaration d'Interlaken. Organisation des Nations Unies pour l'alimentation et l'agriculture, Rome, Italie (disponible à l'adresse électronique http://www.fao.org/docrep/010/a1404f/a1404f00.htm).
van der Werf, J., Graser, H-U., Frankham, R. et Gondro, C. (éds.) 2009. Adaptation and fitness in animal populations. Evolutionary and breeding perspectives on genetic resources management. Springer.

4 *S'il s'agit d'un acte d'une réunion*:
Abad, M., Arrigo, J., Gibbons, A., Lanari, M.R., Morris, G. et Taddeo, H. 2002. Breeding scheme for Angora goat production in North Patagonia. Actes du Septième congrès mondial sur l'application de la génétique à l'élevage, 19-23 août 2002, Montpellier, France, 12–14.

5 *Dans le cas d'informations hébergées sur un site Web:*
FAO. 2010. Domestic Animal Diversity Information System, http://www.fao.org/dad-is/, Organisation des Nations Unies pour l'alimentation et l'agriculture, Rome, Italie.

Dans le cas d'un travail ayant été accepté pour la publication, mais n'ayant pas encore été publié, on écrira «sous presse» à la place de l'année de la publication. Il ne faudra pas écrire l'année prévue de la publication.

Documentation supplémentaire en ligne

La plate-forme en ligne donne la possibilité aux auteurs d'ajouter des données qui seraient autrement impossibles ou pas pratiques à inclure à la version imprimée. Les auteurs pourront inclure des tableaux et des figures ainsi que des données comme des vidéos, des images/structures en trois dimensions, des ensembles de données très détaillées et d'autres matériels supplémentaires ne convenant pas à la reproduction sur papier. Tout le matériel supplémentaire se présentera avec le manuscrit original. Les données supplémentaires seront indiquées dans le texte par le préfixe «S» (par exemple, tableau supplémentaire S1, figure supplémentaire S1). Les fichiers supplémentaires ne seront pas révisés et seront publiés tels que reçus. Les éditeurs devront approuver la publication électronique de ce matériel. Le manuscrit devra être autonome et se suffire à lui-même, sans le matériel supplémentaire (dans l'intérêt des lecteurs ayant uniquement accès à la copie papier).

Processus d'examen

Les manuscrits présentés au journal seront examinés par deux réviseurs externes et évalués par un des éditeurs. Si les éditeurs considèrent que l'article n'est pas pertinent avec ce journal ou que l'examen ne sera pas favorable, l'article pourra être renvoyé à l'auteur après l'examen initial des éditeurs. Ce processus de refus rapide permet à l'auteur de présenter immédiatement son travail ailleurs pour publication. Les manuscrits seront également refusés par les éditeurs s'ils ne sont pas conformes aux recommandations prévues pour leur préparation. Tous les efforts seront faits pour communiquer aux auteurs la décision de l'examen dans un délai de six semaines après la réception du manuscrit. Si les éditeurs demandent des révisions au manuscrit avant sa publication, on accordera un délai maximum d'un mois pour ces révisions.

Epreuves

L'éditeur se réserve le droit de réviser les manuscrits pour veiller à ce que la grammaire et l'orthographe soient cohérentes avec le style du journal. L'auteur principal recevra les épreuves en page pour la correction. Ces épreuves seront contrôlées et renvoyées dans un délai de deux jours après la réception. L'éditeur se réserve le droit de charger les auteurs en cas de correction excessive d'erreurs non typographiques.

Animal Genetic Resources, 2010, 47, 155–157. © Food and Agriculture Organization of the United Nations, 2010
doi:10.1017/S2078633610001165

Instrucciones para los autores

Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales es una revista trilingüe, publicada tres veces al año electrónicamente en internet (http://journals.cambridge.org/AGR) y de forma impresa. Los principales trabajos son publicados en inglés, francés y español, con resúmenes en estos tres idiomas. La revista viene siendo publicada desde el año 1983 y todas las ediciones pasadas están disponibles en el enlace: http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,refcat_50000044

La revista invita a la presentación de trabajos desde cualquier parte del mundo. Aquellos autores que no posean un nivel elevado en alguno de las tres lenguas aceptadas, les solicitamos que busquen la ayuda necesaria en este sentido antes de remitirnos sus manuscritos.

Misión

La revista proporciona un foro internacional para la publicación de trabajos relacionados con la gestión de los recursos genéticos animales para la alimentación y la agricultura (AnGR). En concreto, se tratan las siguientes áreas: caracterización fenotípica y molecular; sondeo y seguimiento; desarrollo (mejora genética); utilización sostenible; desarrollo de las capacidades de los ganaderos y las comunidades de pastores; y políticas e instituciones.

Los editores aceptan todos los trabajos enviados que traten sobre los temas mencionados anteriormente. Trabajos relativos a razas y tecnologías que contribuyan a la gestión sostenible de los sistemas de producción con ingresos medios y bajos en el mundo, que comprenden la mayor parte de las tierras dedicadas a la producción ganadera y la mayor parte de la producción del ganado, que son los que ostentan mayor grado de interés.

La revista apoya la implementación del Plan de Acción Mundial sobre los Recursos Zoogenéticos, el marco de trabajo acordado para la gestión de los AnGR y el Convenio sobre la Biodiversidad.

Descargo de responsabilidad

Los puntos de vista expresados en los trabajos publicados en Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales son solamente las opiniones del autor o autores y, por tanto, no reflejan necesariamente las políticas de la FAO o los puntos de vista de los editores o de las instituciones a las que dichos autores pertenecen.

Evaluación de expertos

Los manuscritos enviados para su publicación en Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales serán estudiados minuciosamente por parte de dos críticos externos. Lo ideal es que los manuscritos sean evaluados por los críticos externos y por los editores, recayendo la decisión final acerca de los mismos sobre los editores.

Categorías de los trabajos

Trabajos sobre investigación – Se tomarán en consideración para su publicación en Recursos genéticos animales los trabajos relacionados con la gestión de los AnGR. Se invita a los autores a incluir las fotografías de alta calidad pertinentes relativas al trabajo presentado en sus manuscritos. Si las fotografías ilustran animales, éstas deben mostrar el entorno de producción primario al que estos animales se han adaptado.

Trabajos de revisión – Se podrán tomar en consideración ocasionalmente aquellos trabajos que presenten una revisión del desarrollo a nivel de nacional, regional o mundial en uno o más aspectos de la gestión de los AnGR. Estos trabajos podrán incluir las revisiones del estado actual de campos específicos de la gestión de los AnGR.

Artículos específicos – Los artículos relacionados con los temas de la revista serán publicados cuando los editores lo consideren oportuno.

***Otros trabajos publicados*:** Se invita a los lectores a enviar la siguiente información a la dirección de correo electrónico: AnGR-Journal@fao.org

- Revisiones o propuestas de libros.
- Conclusiones y recomendaciones resultantes de reuniones, talleres y conferencias relevantes.
- Anuncios de cursos de capacitación y eventos a nivel nacional, regional o internacional.

Originalidad y copyright

Para poder ser publicado en la revista Recursos genéticos animales, el manuscrito deberá no haber sido publicado previamente o estar bajo estudio para ser publicado. (Los datos que hayan sido publicados previamente podrán ser usados en la revista con precaución y siempre y cuando se obtenga el permiso necesario). Antes de la publicación, el autor del manuscrito deberá firmar y entregar, en su nombre y en el de los co-autores, una autorización y un formulario de consentimiento de transferencia a la editorial. Este formulario se enviará al autor junto con la prueba del artículo a publicar.

Autoría

Los artículos que tengan múltiples autores serán revisados bajo el supuesto de que todos los autores han contribuido a la investigación descrita en el artículo y aprueban tanto el artículo en su totalidad como el envío y la publicación de éste. Contribución al trabajo presentado supone la concepción y el diseño del proyecto, los resultados de los experimentos y/o el análisis e interpretación de los datos. Los autores deberán haber contribuido sustancialmente al borrador o a la revisión de dicho trabajo.

Presentación del Manuscrito

Todos los manuscritos deberán enviarse online, y sin coste alguno para el autor, a través de la página Web: http://journals.cambridge.org/AGR.

Posteriormente al envío del manuscrito, se mandará acuse de recibo junto con un número de referencia y el manuscrito será presentado para ser estudiado. Para toda correspondencia relacionada con el manuscrito, se deberá incluir el número de referencia mencionado.

Se deberán seguir las siguientes instrucciones (para más información, ir a la sección "Preparación y estilo de manuscrito"):

- Los manuscritos se presentarán en ingles, francés o español. Si el manuscrito está escrito en francés o español se deberá incluir un resumen, así como palabras clave en el mismo idioma además del inglés. Todos los artículos publicados presentarán un resumen en inglés, francés y español. Se agradecerá el envío del resumen en los tres idiomas con objeto de reducir gastos de traducción y acelerar el proceso del manuscrito.
- El formato deseado de documento para la presentación es Microsoft Word. No se aceptarán manuscritos enviados en Word Perfect u otros procesadores de texto. Los cuadros se incluirán al final del documento, siguiendo el orden indicado por los marcadores de posición dentro del texto.
- Las figuras deberán presentarse en documentos separados con una resolución apropiada (Para más información ver "Preparación y estilo de manuscrito").
- Se deberá presentar una carta de presentación en un documento por separado. La carta deberá indicar la categoría bajo la que el manuscrito se presenta (Ver apéndice 1) y los datos del autor (número de teléfono, fax, y dirección de correo electrónico).
- Los nombres de los archivos enviados deberán indicar el nombre completo o abreviado del autor principal.
- No se requiere ni deberá enviarse copia en papel del manuscrito, de los cuadros o de las figuras.

Tenga en cuenta que toda correspondencia en relación con los manuscritos presentados y analizados se hará exclusivamente con el autor principal.

Preparación y estilo del manuscrito

El formato del manuscrito deberá tener un espaciamiento doble entre líneas. Las páginas deberán estar numeradas, siendo la página número uno la que lleva el título del artículo. Los márgenes de las páginas deberán tener al menos 2.5 cm. en todas sus caras. La letra debe ser estilo "Arial".

Autores y afiliaciones – Los nombres y afiliaciones de los autores deberán presentarse en el formato siguiente:

E.C. Quispe[1], T.C. Rodríguez[2], L.R. Iñiguez[3] and J.P. Mueller[4]

[1]Universidad Nacional de Huancavelica, Huancavelica, Perú; [2]Universidad Mayor de San Andrés, La Paz, Bolivia; [3]Cochabamba, Bolivia; [4]Instituto Nacional de Tecnología Agropecuaria, Bariloche, Argentina.

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El título abreviado tendrá un máximo de 50 caracteres y aparecerá en la página 1 del manuscrito.

El ***resumen*** no deberá tener estructura o subtítulos y deberá proporcionar al lector una sinopsis que sea independiente del documento. Deberá incluir una breve introducción, la metodología usada, los resultados obtenidos y las conclusiones. El resumen no deberá exceder de 210 palabras en inglés y 250 palabras en francés y español. El resumen deberá ser seguido de tres a cinco palabras clave separadas por una coma. Tanto el resumen como las palabras clave se escribirán en el mismo idioma del manuscrito además del inglés.

El ***texto principal del manuscrito*** deberá empezar en la página número 3 y las referencias deberán comenzar en una página nueva. Las líneas de texto deberán estar numeradas y el manuscrito estructurado con encabezamientos numerados consecutivamente (eje. 1., 1.1, 1.1.1 etc.). Es importante evitar el uso de referencias cruzadas cuando se use la numeración de los encabezamientos, en cuyo caso la editorial eliminará la numeración y aplicará los estilos de encabezamiento en la versión final.

Adicionalmente, los trabajos de investigación deben incluir los siguientes encabezamientos: ***Materiales y métodos, Resultados, Discusión y Conclusiones***.

La ***extensión máxima*** del texto principal del manuscrito no deberá exceder de 10 páginas (8.500 palabras aprox.). En caso de que el texto sea corto, éste no deberá exceder de una página (750 palabras ó 500 palabras si se incluye una imagen).

Los Cuadros deberán ser numerados consecutivamente tal y como están citados en el texto (Cuadro 1, 2 etc.). Cada cuadro deberá aparecer en una página distinta (al final del documento) con la numeración y título arriba y las anotaciones o comentarios debajo del mismo.

Las figuras se numerarán consecutivamente tal y como están citadas en el texto del documento (Figura 1, 2, etc.). Se deberán usar caracteres en cursiva para apartados a, b, c, etc. Cada figura deberá incluir una leyenda. En caso que corresponda, las figuras se deberán enviar en archivos con formato TIFF o EPS, preferiblemente con el mismo tamaño con el que serán reproducidos o publicados. Las ilustraciones o material gráfico deberán enviarse en blanco y negro con una resolución de 1200 dpi; las combinaciones de material gráfico con una resolución de 800 dpi; el material gráfico en modelo de semitono en blanco y negro deberá guardarse bajo el modo "escala de grises" con una resolución de 300 dpi; el material gráfico en modelo de semitono a color se guardará bajo modo "CMYK" con una resolución de 400 dpi. Se deberán obtener todos los permisos necesarios.

Abreviaturas y el sistema internacional de unidades (SI) – No se recomienda el uso de abreviaturas excepto aquellas extensamente utilizadas. Las abreviaturas deberán usarse sólo en caso de que mejoren la comprensión del manuscrito. Los acrónimos deberán ser escritos en palabras completas la primera vez que se mencionen. Se usarán las medidas del sistema métrico internacional (SI).

Lista de agradecimientos

En esta sección el autor deberá hacer mención a la ayuda económica recibida, por parte de las agencias de financiación u otras fuentes,

para la realización del trabajo documentado en el manuscrito. También se podrán incluir, en esta sección, los agradecimientos a las personas que contribuyeron a la investigación pero que no aparecen como autores.

La lista de agradecimientos deberá aparecer después del texto principal antes de las referencias. En caso de que no haya agradecimientos, la palabra "ninguno" seguirá al encabezamiento "Lista de agradecimientos".

Declaración de interés

Existe conflicto de intereses cuando un autor tiene intereses que pudieran influir de forma inapropiada en su opinión o juicio, incluso si su opinión no ha sido finalmente influenciada. Por esta razón, los autores deberán revelar conflictos de intereses potenciales de forma que se pueda evaluar sobre sus efectos. En el momento en que se envíe el manuscrito, los autores deberán revelar cualquier acuerdo o conexiones económicas que puedan tener, que sean pertinentes al manuscrito enviado y que puedan ser percibidas como potencial amenaza a la imparcialidad del documento. También deberán declararse los intereses no-financieros que pudieran ser relevantes en este contexto. En caso de que no haya intereses relevantes, deberá también indicarse. Este requerimiento será aplicable a todos autores del documento y a todas las categorías de documentos.

Referencias

Toda referencia presente en el texto deberá aparecer en la lista de referencias y, de la misma manera, cada referencia de la lista deberá haber sido citada por lo menos una vez en el texto. Las referencias deben ir en orden alfabético del apellido del autor, seguido por el año.

Ejemplos:

1. *Ejemplo en el caso de una referencia de una revista*:
   Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10: 53–64.
2. *Cuando se trate de más de un autor*:
   Matos, C.A.P., Thomas, D.L., Gianola, D., Tempelman, R. J. & Young, L.D. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and non-linear models: 1. Estimation of genetic parameters, *Journal of Animal Science* 75: 76–87.
3. *En el caso de un libro o de una publicación ad hoc, por ejemplo informes, tesis, etc*.
   FAO, 2007. Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration. Food and Agriculture Organization of the United Nations, Rome, Italy (available at http://www.fao.org/docrep/010/a1404e/a1404e00.htm).
   Van der Werf, J., Graser, H-U., Frankham, R. & Gondro, C. (eds.) 2009. Adaptation and fitness in animal populations. evolutionary and breeding perspectives on genetic resources management. Springer.
4. *Cuando se trate de un artículo dentro de las actas de una reunión*:
   Abad, M., Arrigo, J., Gibbons, A., Lanari, M.R., Morris, G. & Taddeo, H. 2002. Breeding scheme for Angora goat production in North Patagonia. Proceedings 7th World Congress on Genetics Applied to Livestock Production, 19-23 August 2002, Montpellier, France, 12–14.
5. *Cuando la información contenida en el artículo haya sido obtenida o derive de un sitio Web*:
   FAO. 2010. Domestic Animal Diversity Information System, http://www.fao.org/dad-is/, Food and Agriculture Organization of the United Nations, Rome, Italy.

En caso de trabajos que hayan sido aceptados para publicación pero que no hayan sido todavía publicados, se deberá escribir "en prensa" en lugar del año de publicación. No deberá indicarse el año estimado de publicación.

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La plataforma online ofrece a los autores la oportunidad de incluir datos que serían imposibles o impracticables de incluir en la versión impresa de la revista. Los autores podrán incluir cuadros y figuras, así como videos, imágenes 3-D, grandes bases de datos o cualquier material adicional que no se pueda imprimir. Todo material suplementario deberá ser enviado con el manuscrito original. Los datos suplementarios deberán referirse en el texto del documento con el prefijo "S" (ej. Cuadro suplementario S1, Figura suplementaria S1). Los archivos suplementarios o adicionales no serán editados ni corregidos, y serán publicados tal y como se envíen. La publicación electrónica del material suplementario necesitará ser aprobada por los editores. Por otra parte, el manuscrito deberá ser autónomo sin el material suplementario (en beneficio de los lectores que sólo tengan acceso a la copia impresa).

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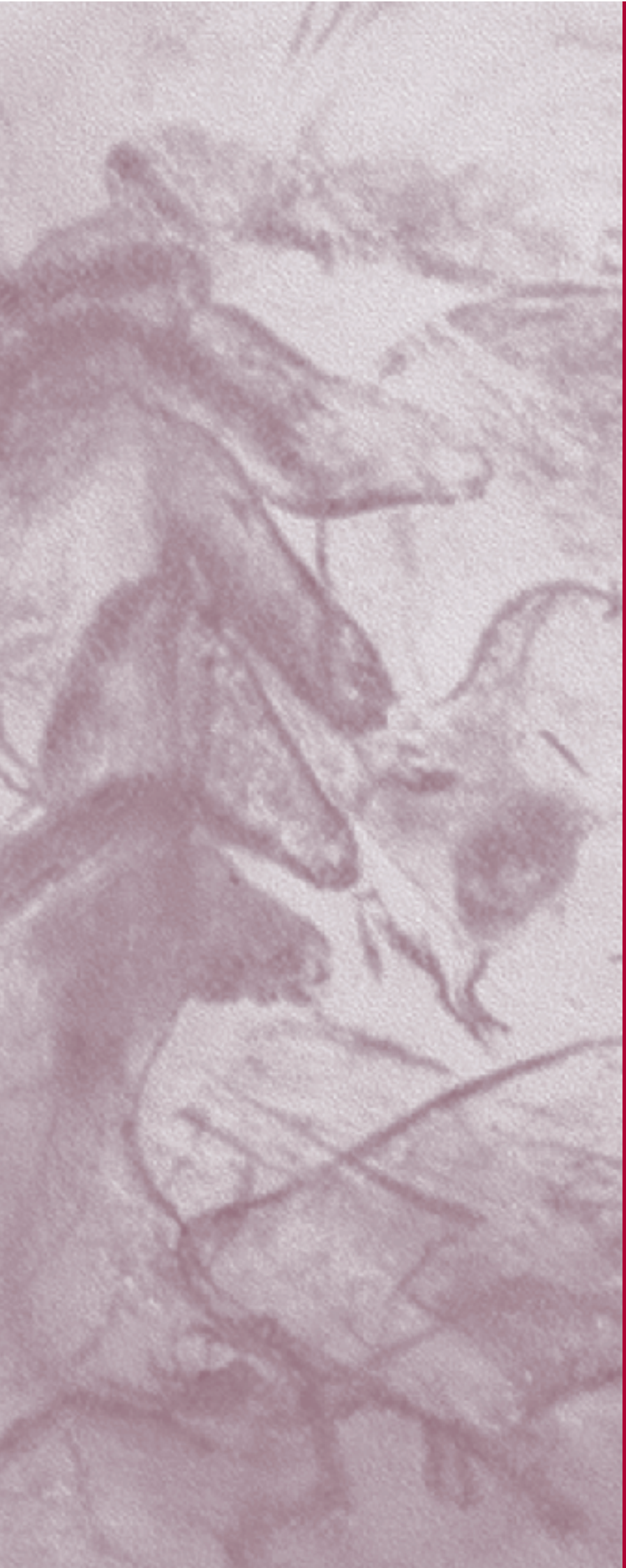

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