

**41**  
**2007**

ISSN 1014-2339

**ANIMAL GENETIC  
RESOURCES  
INFORMATION**

---

Special issue:  
Interlaken International Conference

**BULLETIN  
D'INFORMATION  
SUR LES RESSOURCES  
GÉNÉTIQUES ANIMALES**

---

Numéro spécial:  
Conférence Internationale d'Interlaken

**BOLETÍN  
DE INFORMACIÓN  
SOBRE RECURSOS  
GENÉTICOS ANIMALES**

---

Numero especial:  
Conferencia Internacional de Interlaken



---

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

---

Les appellations employées dans ce produit d'information et la présentation des données qui y figurent n'impliquent de la part de l'Organisation des Nations Unies pour l'alimentation et l'agriculture aucune prise de position quant au statut juridique ou au stade de développement des pays, territoires, villes ou zones ou de leurs autorités, ni quant au tracé de leurs frontières ou limites.

---

Las denominaciones empleadas en este producto informativo y la forma en que aparecen presentados los datos que contiene no implican, de parte de la Organización de las Naciones Unidas para la Agricultura y la Alimentación, juicio alguno sobre la condición jurídica o nivel de desarrollo de países, territorios, ciudades o zonas, o de sus autoridades, ni respecto de la delimitación de sus fronteras o límites.

---

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders. Applications for such permission should be addressed to the Chief, Electronic Publishing Policy and Support Branch, Communication Division, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy or by e-mail to [copyright@fao.org](mailto:copyright@fao.org)

© FAO 2007

---

Tous droits réservés. Les informations contenues dans ce produit d'information peuvent être reproduites ou diffusées à des fins éducatives et non commerciales sans autorisation préalable du détenteur des droits d'auteur à condition que la source des informations soit clairement indiquée. Ces informations ne peuvent toutefois pas être reproduites pour la revente ou d'autres fins commerciales sans l'autorisation écrite du détenteur des droits d'auteur. Les demandes d'autorisation devront être adressées au Chef de la Sous-division des politiques et de l'appui en matière de publications électroniques, Division de la communication, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italie ou, par courrier électronique, à [copyright@fao.org](mailto:copyright@fao.org)

© FAO 2007

---

Todos los derechos reservados. Se autoriza la reproducción y difusión de material contenido en este producto informativo para fines educativos u otros fines no comerciales sin previa autorización escrita de los titulares de los derechos de autor, siempre que se especifique claramente la fuente. Se prohíbe la reproducción del material contenido en este producto informativo para reventa u otros fines comerciales sin previa autorización escrita de los titulares de los derechos de autor. Las peticiones para obtener tal autorización deberán dirigirse al Jefe de la Subdirección de Políticas y Apoyo en Materia de Publicación Electrónica de la Dirección de Comunicación de la FAO, Viale delle Terme di Caracalla, 00153 Roma, Italia, o por correo electrónico a [copyright@fao.org](mailto:copyright@fao.org)

© FAO 2007

---

ISBN 978-92-5-005764-4

Editors - Editeurs - Editores:  
S. Galal & I. Hoffmann

Viale delle Terme di Caracalla,  
00153 Rome, Italy

*Animal Genetic Resources Information* is published under the auspices of the Food and Agriculture Organization of the United Nations (FAO). It is edited in the Animal Genetic Resources Group of the Animal Production and Health Division of FAO. It is available direct from FAO or through FAO sales agents.

*ANIMAL GENETIC RESOURCES INFORMATION* will be sent free of charge to those concerned with the sustainable development conservation of domestic livestock. Anyone wishing to receive it regularly should send their name and address to the Editor, at the address shown above.

AGRI can also be found in the "Library" of DAD-IS at [www.fao.org/dad-is](http://www.fao.org/dad-is).

*Le Bulletin d'information sur les ressources génétiques animales* est publié sous les auspices de l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO). Cette publication est éditée par le Groupe des ressources génétiques de la Division de la production et de la santé animales de la FAO. On peut se le procurer directement au siège de la FAO ou auprès des dépositaires et agents de vente des publications de l'Organisation.

LE BULLETIN D'INFORMATION SUR LES RESSOURCES GÉNÉTIQUES ANIMALES sera envoyé gratuitement aux personnes intéressées par le développement durable et la conservation du cheptel national. Les personnes souhaitant recevoir cette publication régulièrement voudront bien faire parvenir leurs nom et adresse à l'éditeur, à l'adresse susmentionnée.

AGRI peut être consulté également dans la "Bibliothèque" de DAD: [www.fao.org/dad-is](http://www.fao.org/dad-is).

El Boletín de información sobre recursos genéticos animales se publica bajo los auspicios de la Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). Se edita en el Grupo de Recursos Zoogenéticos de la Dirección de Producción y Sanidad Animal de la FAO. Se puede obtener directamente de la FAO o a través de sus agentes de venta.

EL BOLETÍN DE INFORMACIÓN SOBRE RECURSOS GENÉTICOS ANIMALES será enviado gratuitamente a quienes estén interesados en el desarrollo sostenible y la conservación del ganado doméstico. Si se desea recibirlo regularmente, se ruega comunicar nombre, apellido y dirección al editor a la dirección arriba indicada.

AGRI puede consultarse también en la "Biblioteca" de DAD-IS en: [www.fao.org/dad-is](http://www.fao.org/dad-is).

**ANIMAL GENETIC  
RESOURCES INFORMATION**

**BULLETIN  
D'INFORMATION  
SUR LES RESSOURCES  
GÉNÉTIQUES ANIMALES**

**BOLETÍN DE  
INFORMACIÓN SOBRE RECURSOS  
GENÉTICOS ANIMALES**

**CONTENTS**

Page

Editorial .....	I
Passing on the fire - To further inspire people to contribute in the management of animal genetic resources .....	1
<i>B. Kubbinga, I. Hoffmann &amp; B. Scherf</i>	
Randall cattle in the USA: rescuing a genetic resource from extinction .....	9
<i>D.P. Sponenberg, C. Creech &amp; W.J. Miller</i>	
Puesta en valor de un sistema tradicional y de sus recursos genéticos mediante una Indicación Geográfica: El proceso de la Carne Caprina del Norte Neuquino en la Patagonia Argentina .....	17
<i>M. Pérez Centeno, M.R. Lanari, P. Romero, L. Monacci, M. Zimmerman, M. Barrionuevo, A. Vázquez, M. Champredonde, J. Rocca, F. López Raggi &amp; E. Domingo</i>	
Experience in establishing a herd book for the local Nguni breed in South Africa .....	25
<i>M.M. Scholtz &amp; K.A. Ramsay</i>	
Development of international genetic evaluations of dairy cattle for sustainable breeding programs .....	29
<i>W.F. Fikse &amp; J. Philipsson</i>	
Genetic diversity and sustainable management of animal genetic resources, globally .....	45
<i>E. Fimland</i>	
Integrating policies for the management of animal genetic resources with demand for livestock products and environmental sustainability .....	53
<i>H.D. Blackburn</i>	

"Table of content" continued on page 4



What's on the menu? Options for strengthening the policy and regulatory framework for the exchange, use and conservation of animal genetic resources1 .....	65
<i>S.J. Hiemstra, A.G. Drucker, M.W. Tvedt, N. Louwaars, J.K. Oldenbroek, K. Awgichew, S. Abegaz Kebede, P.N. Bhat &amp; A. da Silva Mariante</i>	
Back to the future. How scenarios of future globalisation, biotechnology, disease and climate change can inform present animal genetic resources policy development .....	75
<i>A.G. Drucker, S.J. Hiemstra, N. Louwaars, J.K. Oldenbroek, M.W. Tvedt, I. Hoffmann, K. Awgichew, S. Abegaz Kebede, P.N. Bhat &amp; A. da Silva Mariante</i>	
Regulatory options for exchange, use and conservation of animal genetic resources: a closer look at property right issues .....	91
<i>M.W. Tvedt, S.J. Hiemstra, A.G. Drucker, N. Louwaars &amp; J.K. Oldenbroek</i>	
Genetic impact assessments – summary of a debate .....	101
<i>D. Pilling</i>	
Country Contributions .....	109
Recent publications .....	125
Editorial Policies and Procedures .....	133

## Editorial Advisory Board (EAB) of Animal Genetic Information (AGRI)

- Editor-in-Chief: I. Hoffmann, Chief Animal Production Service, FAO
- Editor: S. Galal (Egypt)
- Technical Editor: C. Mosconi (Italy)
- Editorial Board: L. Ollivier, Chairperson (France)  
L. Alderson (United Kingdom)  
J.S. Barker (Australia)  
P. Bhat (India)  
J.V. Delgado Bermejo (Spain)  
M. Djemali (Tunisia)  
J. Hodges (Canada)  
K. Ramsay (South Africa)  
E. Rege (ILRI)  
A. Tewolde (Mexico)

The following is the address for each of the members of the Editorial Advisory Board.

- Irene Hoffmann, FAO, Viale delle Terme di Caracalla 1, 00100 Rome, Italy  
Tel.: +33 06 5705 52796, irene.hoffmann@fao.org
- Salah Galal, Animal Production Department, Faculty of Agriculture, University of Ain Shams, PO Box 68, Hadaeq Shubra 11241, Cairo, Egypt  
Tel.: +20 2 634408, sgalal@tedata.net.eg
- Louis Ollivier, INRA-Station de Génétique Quantitative et Appliquée, CRJ, Domaine de Vilvert, 78352 Jouy-en-Josas Cédex, France  
Tel.: +33 1 34652190, ugenlol@dga2.jouy.inra.fr
- Lawrence Alderson, Countrywide Livestock Ltd, 6 Harnage, SY5 6EJ Shrewsbury, Shropshire, UK  
Tel.: +44 195 2510030, alderson@clltd.demon.co.uk
- J. Stuart Barker, Dept. of Animal Science, University of New England, NSW 2351 Armidale, Australia  
Tel.: +61 7 54358365, sbarker@une.edu.au
- Pushkar Nath Bhat, Indian Association for Animal Production, World Buffalo Trust, Flat N° 205 N° F64-C/9 Sector 40, 201 303 Noida (UP), India  
Tel.: +91 11 91579627, pnbhat@bol.net.in
- Juan Vicente Delgado Bermejo, Departamento de Genética, Universidad de Córdoba, Campus de Rabanales Edificio C-5 (Gregor Mendel), 14071 Córdoba, Spain  
Tel.: +34 957 218661, id1debej@lucano.uco.es
- Mnouer Djemali, Institut National Agronomique de Tunis, 43, avenue Charles Nicole, Tunis, Tunisia,  
Tel.: +216 1 289683/289431, djemali.mnaouer@inat.agrinet.tn
- John Hodges, Lofererfeld 16, 5730 Mittersill, Austria,  
Tel.: +43 6562 5481, hodgesjohn@compuserve.com
- Keith Ramsay, Senior Livestock Specialist, Private Bag X 138, 0001 Pretoria, Gauteng, South Africa  
Tel.: +27 12 3197448, KeithR@nda.agric.za
- Ed Rege, International Livestock Research Institute (ILRI), P.O. Box 30709, 00100 Nairobi, Kenya  
Tel.: +254 20 4223201, e.rege@cgiar.org
- Assefaw Tewolde, Inovacion y Tecnologia/Biotecnologia, Instituto Interamerican de Cooperacion para la Agricultura (IICA), Sede Central, Coronado, San Jose, Costa Rica, atewolde@uamac.uat.mx
- Cesare Mosconi, EAAP, Via G. Tomassetti 3, 00161 Rome, Italy  
Tel.: +39 06 44202639, mosconi@eaap.org



---

## Editorial - The First International Technical Conference on Animal Genetic Resources

Sustainable management of the world's animal genetic resources is of vital importance to agriculture, food production, rural development and the environment. The first International Technical Conference on Animal Genetic Resources to be held in Interlaken, Switzerland, in September 2007 will raise awareness among stakeholders and promote improved policy development and cooperation at all levels.

The conference will see the launch of *The State of the World's Animal Genetic Resources for Food and Agriculture* – the first global assessment of the status and management of livestock biodiversity. The *State of the World* is the culmination of a long process of reporting, analysis, writing and reviewing, which has involved a great number of individuals throughout the world. The 169 Country Reports submitted to FAO were key sources of information, supplemented by reports from international organizations, specially commissioned thematic studies, and the knowledge of the authors and reviewers. The country-based reporting process has already stimulated policy development at national level and led to the elaboration of a *Global Plan of Action for Animal Genetic Resources*, which once adopted, will provide an agenda for action by the international community. The Interlaken Conference will mark a historic opportunity for the international community to make strategic choices for the future management of animal genetic resources.

This special issue of AGRI reflects the efforts made by governments, INGOs, NGOs, livestock keepers, and FAO in the area of animal genetic resources. It reviews the development of AnGR-related activities, presents examples of breed

improvement and conservation measures, and discusses a number of policy issues. Also included are 17 contributions highlighting national actions in animal genetic resources management that have been implemented subsequent to the preparation of the Country Reports on the State of Animal Genetic Resources. These examples underscore the contribution of the *The State of the World* process to raising awareness of animal genetic resources, and illustrate that this has led to action at technical and policy levels. They also highlight the need for further action in various aspects of animal genetic resources management.

The adoption of a *Global Plan of Action for Animal Genetic Resources* is another intended outcome of the Interlaken Conference. The *Global Plan of Action* will provide a basis, agreed by the international community, to support and increase the overall effectiveness of national, regional and global efforts for the sustainable use, development and conservation of animal genetic resources, and to sustainably mobilize resources. It is intended as a rolling plan with an initial time horizon of ten years. Prospects for the *Global Plan of Action* are enhanced by a growing awareness that countries are fundamentally interdependent with respect to animal genetic resources for food and agriculture, and that substantial international cooperation is necessary to ensure the effective management of animal genetic diversity.

We gratefully acknowledge the efforts of the authors who contributed articles to this issue and provided their papers at short notice.

The Editors

---

---

## Éditorial - La première Conférence Technique Internationale sur les Ressources Génétiques Animales

La gestion durable des ressources génétiques animales au niveau mondial est d'une importance vitale pour l'agriculture, la production alimentaire, le développement rural et l'environnement. La première Conférence Technique Internationale sur les Ressources Génétiques Animales qui aura lieu à Interlaken, en Suisse, en septembre 2007, augmentera la sensibilisation entre les parties intéressées du secteur de l'élevage et encouragera l'amélioration des politiques de développement et de la coopération à tous les niveaux.

La conférence servira aussi au lancement du document sur la *Situation Mondiale des Ressources Génétiques Animales pour l'Alimentation et l'Agriculture* – première évaluation au niveau mondial sur la situation et la gestion de la biodiversité en élevage. La *Situation Mondiale* est le point culminant d'un long processus fait de rapports, d'analyses, de rédactions et de révisions qui a compté avec un grand nombre d'individus en provenance de différents parties du monde. Les 169 Rapports Nationaux soumis à la FAO ont été une source essentielle d'informations complétées avec les rapports réalisés par les organisations internationales auxquelles avaient été demandé des études sur des thèmes spécifiques, et avec la connaissances des auteurs et des réviseurs. Le processus d'élaboration des rapports nationaux a contribué à la stimulation de politiques de développement au niveau national et a porté à l'élaboration du *Plan Mondial d'Action pour les Ressources Génétiques Animales* qui, après approbation, permettra d'établir un agenda de travail pour les actions à réaliser par la communauté internationale. La Conférence d'Interlaken offrira une occasion historique à toute la communauté internationale pour définir les choix stratégiques pour la gestion future des ressources génétiques animales.

Ce numéro spécial de AGRI reflète les efforts réalisés par les gouvernements, les INGO et NGO, les éleveurs et la FAO dans le domaine des ressources génétiques animales. Il présente une

révision du développement des activités en relation avec les AnGR ainsi que des exemples sur amélioration de race et mesures de conservation, et on discute d'un certain nombre de thèmes politiques. Ce numéro comprend aussi 17 articles qui soulignent les actions au niveau national dans la gestion des ressources génétiques animales qui ont été entreprises comme conséquence de la préparation des Rapports Nationaux sur la Situation des Ressources Génétiques Animales. Ces exemples soulignent aussi l'importance du document sur la *Situation Mondiale* tout au long du processus de sensibilisation au thème des ressources génétiques animales et illustrent comment il a conduit à des actions concrètes au niveau technique et politique. Le numéro reporte aussi le besoin d'ultérieures actions nécessaires à différents niveaux de la gestion des ressources génétiques animales.

L'adoption du *Plan Mondial d'Action pour les Ressources Génétiques Animales* est l'autre objectif que nous essayerons d'atteindre pendant la Conférence d'Interlaken. Avec l'accord de la communauté internationale, le *Plan Mondial d'Action* donnera les bases nécessaires pour soutenir et augmenter l'efficacité globale au niveaux national, régional et mondial de tous les efforts pour l'utilisation durable, le développement et la conservation des ressources génétiques animales, et la durabilité dans la mobilisation des ressources. Cet événement est conçu pour établir un objectif initial avec un horizon de dix ans. Les probabilités que le *Plan Mondial d'Action* soit amélioré grâce à une majeure sensibilisation dépendra si les pays sont fondamentalement interdépendants par rapport aux ressources génétiques animales pour l'alimentation et l'agriculture, et de la coopération internationale qui devra assurer une gestion effective de la diversité génétique animale.

Nous voulons remercier les efforts de tous les auteurs qui ont contribué à ce numéro en envoyant leurs articles avec un si court délai.



---

## Editorial - La primera Conferencia Técnica Internacional sobre Recursos zoogenéticos

La gestión sostenible de los recursos zoogenéticos a nivel mundial es de vital importancia para la agricultura, la producción de alimentos, el desarrollo rural y el ambiente. La primera Conferencia Técnica Internacional sobre Recursos Zoogenéticos que tendrá lugar en Interlaken, Suiza, en septiembre 2007, tratará de concienciar la gestión sostenible de los recursos zoogenéticos a nivel mundial es de vital importancia para la agricultura, la producción de alimentos, el desarrollo rural y el ambiente. La primera Conferencia Técnica Internacional sobre Recursos Zoogenéticos que tendrá lugar en Interlaken, Suiza, en septiembre 2007, tratará de concienciar las partes interesadas en el sector ganadero y promoverá la mejora de políticas de desarrollo y la cooperación a todos los niveles.

La conferencia será también el marco para la presentación del documento sobre la *Situación Mundial de los Recursos Zoogenéticos para la Alimentación y la Agricultura* – primera valoración a nivel mundial sobre la situación y gestión de la biodiversidad ganadera. La *Situación Mundial* es la culminación de un largo proceso formado de informes, análisis, redacciones y revisiones que ha involucrado un gran número de individuos provenientes de todo el mundo. Los 169 Informes Nacionales sometidos a la FAO han sido una fuente clave de información que ha sido complementada con los informes realizados por las organizaciones internacionales, a las que se han solicitado estudios temáticos específicos, y con el conocimiento de los autores y revisores. El proceso de elaboración de los informes nacionales ha contribuido a estimular las políticas de desarrollo a nivel nacional y ha llevado a la elaboración del *Plan Mundial de Acción para los Recursos Zoogenéticos* que una vez aprobado permitirá elaborar una agenda de trabajo para las acciones a realizar por parte de la comunidad internacional. La Conferencia de Interlaken proporcionará una oportunidad histórica a toda la comunidad internacional para definir elecciones estratégicas para la futura gestión de los recursos zoogenéticos.

Este número especial de AGRI refleja los esfuerzos realizados por los gobiernos, las INGO y NGO, los ganaderos y la FAO en el terreno de los

recursos zoogenéticos. Se hace una revisión del desarrollo de las actividades relacionadas con AnGR, se presentan ejemplos de mejora de raza y medidas de conservación, y se discuten un cierto número de temas políticos. Este número también incluye 17 artículos que subrayan las acciones a nivel nacional en la gestión de los recursos zoogenéticos que han sido realizadas como consecuencia a la preparación de los Informes Nacionales sobre la Situación de los Recursos Zoogenéticos. Estos ejemplos recalcan la importancia del documento sobre la *Situación Mundial* en todo el proceso de concienciación sobre los recursos zoogenéticos e ilustran cómo ha llevado también a acciones concretas a nivel técnico y político. También se recalca la necesidad de posteriores acciones necesarias en distintos aspectos de la gestión de los recursos zoogenéticos.

La adopción del *Plan Mundial de Acción para los Recursos Zoogenéticos* es otro de los logros que se intenta obtener durante la Conferencia de Interlaken. El *Plan Mundial de Acción* proporcionará las bases, con el acuerdo de la comunidad internacional, para apoyar e incrementar la eficacia global a nivel nacional, regional y mundial de los esfuerzos para la utilización sostenible, el desarrollo y conservación de los recursos zoogenéticos, y la sostenibilidad en la movilización de los recursos. Este evento está concebido para establecer un objetivo inicial con un horizonte de diez años. Las probabilidades de que el *Plan Mundial de Acción* se vea realizado con una mayor concienciación dependerá de que los países sean fundamentalmente interdependientes con respecto a los recursos zoogenéticos para la alimentación y la agricultura, para lo que será necesaria una cooperación internacional importante para asegurar la gestión efectiva de la diversidad genética animal.

Queremos agradecer los esfuerzos de todos los autores que han contribuido a este número enviando sus artículos con tan previo aviso.

Los Editores

---



# Passing on the fire - To further inspire people to contribute to the management of animal genetic resources

*B. Kubbinga, I. Hoffmann & B. Scherf*

*Animal Health and Production Division, Food and Agriculture Organization,  
Viale delle Terme di Caracolla, 00153 Rome, Italy*

## Summary

In light of the upcoming first International Technical Conference on Animal Genetic Resources (September 2007), experts have been interviewed to tell about their experiences in the management of animal genetic resources over the past fifty years. They identified three milestones in the history of Animal Genetic Resources (AnGR) management: the foundation of the Rare Breeds Survival Trust (1973), the FAO/UNEP 1980 Technical Consultation on AnGR, and the signing of the Convention on Biological Diversity (1992). Conservation of AnGR started at grassroot level and eventually led to policies at governmental level. The passion of civil society organizations remains vital to conserve local livestock breeds. Technical and financial support will be crucial for the future of AnGR conservation. The next milestone will be a Global Plan of Action that is expected as one outcome of the International Technical Conference.

## Résumé

En vue de la prochaine Conférence Technique Internationale sur les Ressources Génétiques Animales qui aura lieu en septembre 2007, on a interrogé une série d'experts pour connaître leurs expériences dans la gestion des ressources génétiques animales au cours des derniers 50 ans. Trois points principaux ont été identifiés tout au long de l'histoire de la gestion des Ressources Génétiques Animales (AnGR):

1. la création en 1973 du *Rare Breeds Survival Trust*;
2. la Consultation Technique sur AnGR organisée par la FAO/UNEP en 1980; et
3. la signature de la Convention pour la Biodiversité de 1992.

La conservation de AnGR commence à un niveau de base et éventuellement conduit à des politiques au niveau gouvernemental. Les supports technique et financier seront d'importance cruciales

pour le futur de la conservation de AnGR. Le prochain défi sera la Plan Mondial d'Action qui on espère sera un des résultats à la fin de la Conférence Technique Internationale.

## Resumen

En vistas de la próxima Conferencia Técnica Internacional sobre Recursos Zoogenéticos que tendrá lugar en septiembre 2007, se han entrevistado una serie de expertos para conocer sus experiencias en la gestión de los recursos zoogenéticos en los últimos cincuenta años. Han identificado tres puntos principales a lo largo de la historia de la gestión de los Recursos Zoogenéticos (AnGR):

1. la creación en 1973 de *Rare Breeds Survival Trust*;
2. la Consulta Técnica sobre AnGR de la FAO/UNEP en 1980; y
3. la firma de la Convención sobre la Diversidad Biológica del 1992.

La conservación de AnGR empieza a nivel de base y eventualmente conduce a políticas a nivel gubernamental. Los soportes técnico y financiero serán cruciales para el futuro en la conservación de AnGR. El próximo reto será el Plan Mundial de Acción que se espera sea uno de los resultados de la Conferencia Técnica Internacional.

**Keywords:** *Animal genetic resources for food and agriculture, NGO, Research, Government, FAO, State of the World, Interlaken.*

## Introduction

Why have animal genetic resources for food and agriculture (AnGR) become more prominent on the international agenda over the past fifty years? And what moved people to conserve and promote the sustainable use of the incredible diversity of cattle,

pigs, sheep, goats, poultry, and the many other existing livestock species?

This paper gives some answers to these two questions. The occasion to look into these questions is the forthcoming International Technical Conference on Animal Genetic Resources, which will be held from 1 till 7 September 2007 in Interlaken, Switzerland. As it is the first such Technical Conference, and is expected to adopt a Global Plan of Action for Animal Genetic Resources, it represents an important milestone in the history of AnGR management. Hence, it is opportune to look back into the past and discover what milestones have preceded the upcoming event, and to show what the motivation is of people who have been or still are wholeheartedly involved in the management of AnGR.

The paper is based on a series of interviews with AnGR experts from all over the world. The names of many of our informants are mentioned, however, innumerable individuals and institutions or constituencies have contributed to the AnGR programme. The lack of reference to such key partners in the text does not imply the non-recognition of their inputs.

The structure follows the three milestones they identified over the past half-century: the first milestone was laid in 1973, when the first NGO - the Rare Breeds Survival Trust (RBST) - was founded in the United Kingdom. The FAO/UNEP 1980 Technical Consultation on AnGR that took place in Rome was the second. Finally, the signing of the Convention on Biological Diversity in 1992 represents the third milestone. Building upon this structure, the paper recounts the invaluable experiences of experts to show their never-ending passion - the same passion that we as human kind will need in the coming years to sustainably use and conserve Animal Genetic Resources for food and agriculture in all regions of the world.

## The first milestone: the start of conservation at grassroot level

*"It has been my perception that interest in conserving farm animal genetic resources began almost simultaneously and independently in many different countries and at many different levels. Most of the beginnings occurred during the 1960s", says Roy Crawford (Canada). "Yet the first milestone was laid in 1973, when*

*Lawrence Alderson started the Rare Breeds Survival Trust in the UK".*

Arthur da Silva Mariante (Brazil), later involved in setting up Rare Breeds International that took the work of the RBST to an international level, gives the Trust the same credit: *"It became the first NGO to fully commit itself to the conservation of local breeds".*

Three decades earlier, in the 1940s, the picture looked completely different: 'conservation' was not on the agenda. It was a time of fast changes in the livestock sector. In many developed countries, the levels of production were raised in response to the rapid rise in demand for animal products. Animals were selected that could provide meat and dairy products in the shortest time possible, and efficient breeding programmes were applied to use these animals on a large scale.

An important factor in these breeding programmes was the availability of new breeding techniques. The most important one was developed by the Russians in 1899: reproduction via Artificial Insemination (AI). This revolutionized the use of livestock, not only in the developed world, but also in the developing countries. As mobility had been given an enormous boost - people could now travel in no-time to other parts of the world, by train, boat or airplane - this meant that also animals or their genetic material, together with related production technologies, could now easily be moved around the globe.

In the same period, just after the Second World War, the FAO was founded (FAO, 1945). It became directly involved in this global move. As the mandate of FAO was *"to improve agricultural productivity, better the lives of rural people and contribute to the growth of the world economy"*, the new knowledge on farm animal breeding was soon transferred to the rest of the world. The exportation of temperate breeds into tropical and subtropical areas, which had already started a few decades earlier, was continued.

*"Few people realized that these exotic breeds could be harmful for local breeds",* tells John Hodges (United Kingdom). Yet he adds: *"Some people were aware of the problem. Government officials who came back from the colonial states had witnessed the problems of introducing exotic breeds into tropical areas"*. Despite the awareness, however, governments and donors in developed countries would not refrain from exporting breeds with high yield potential, in their well-meaning attempts to improve production also in developing countries - yet without always

providing the necessary expertise on how to manage these breeds.

Attention for this matter was also raised at the FAO. In 1946, the FAO convened a meeting of a Standing Advisory Committee on Agriculture. One of the topics for this meeting was 'Animal Genetic Resources'. Ralph Philips (United States of America) was invited to the Committee: "*One of my contributions to its work was the drafting of a recommendation – which the Committee adopted – that the FAO should undertake work on the cataloguing of animal genetic stocks*" (Philips, 1981). Although FAO created an international study group in 1965 to issue recommendations on the evaluation, utilization and conservation of AnGR (FAO, 1967), cataloguing would remain the primary activity for many years.

On an individual basis, the cataloguing had already been started by Ian Mason<sup>1</sup> in the 1940s. His work was a significant step in the evaluation of the existing livestock breeds, although compiling catalogues of breeds was just a first step in the conservation of breeds. As the process of introducing 'improver' animals continued, many indigenous breeds in and outside Europe became rare. But things changed in the 1960s.

"*It began very naively in 1964 when I recognized the rapidly advancing erosion of poultry genetic resources, I felt that something had to be done to stem the tide, and presumed that I was the only one who cared about the situation*", says Roy Crawford. Crawford decided to take care of rare poultry breeds at the university and even at home. "*His situation was typical for the sporadic activities that came about elsewhere*"<sup>2</sup>, says Imre Bodó (Hungary). Interestingly, one of these early initiatives would develop into a major step forward in the management of AnGR.

"*In the early 1960s, a small group of people belonging to the Zoological Society of London realized that many native breeds were endangered, and they decided to keep small herds in London Zoo in order to preserve them*," tells Lawrence Alderson (United Kingdom), "*The first farm animals that were saved were cattle and sheep; other species like horses, goats and pigs soon followed*".

Alderson himself joined this London-based group of conservationists in 1969. He had spent his youth on a dairy farm, and was now a young business consultant with a special interest in native breeds. He realized that the best way to promote the conservation of AnGR in the UK was by creating a separate organisation. In 1973, Alderson's idea resulted in the foundation of RBST – most probably the first NGO in the world concerned with the conservation of endangered breeds.

The creation of RBST was the first milestone in the history of AnGR management. Roy Crawford believes it is no coincidence that it was set up by a grassroots organisation. "*Conservation work requires passion – grassroots have that in abundance*", says Crawford, "*That is why grassroots started the movement*."

Grassroot organisations, like RBST, had already seen the need for conservation in the 1960s. It would take almost two decades before this consciousness would move up – from the bottom – to the agenda of governments. RBST was founded in the middle of this process and provided the first input to the government from the level of NGOs.

## The second milestone: FAO adopts 'conservation'

"*This was the real beginning of the AnGR movement!*" says Stuart Barker (Australia), referring to the Technical Consultation of 1980 held in Rome. Kalle Maijala (Finland) and Louis Ollivier (France) agree: "*The Technical Consultation in 1980 was most important*."

It was in the 1970s that the concept of 'conservation' entered the picture at a governmental level. This process was generally slow. Grassroot organisations had to convince both the general public and the scientific community that more public and financial support was needed. "*It took a long time to convince agricultural advisors as they still thought that replacing breeds was good*," tells Hans-Peter Grunenfelder, founder of the Swiss NGO Pro Specie Rara and the European umbrella organization SAVE Foundation. With the support they gained, "*NGOs did a lot to convince governments about the need for conservation*".

At the FAO, the process was equally slow. "*It was Ian Mason who brought the interest in indigenous*

<sup>1</sup> Ian Mason (14 February 1914 - 21 May 2007) belonged to the first people involved in AnGR management. He has worked his entire life on the documentation and conservation of breeds from all over the world. His most famous work *A World Dictionary of Livestock Breeds, Types and Varieties* was first published in 1951 and has been an important information source ever since (the fifth edition appeared in 2002).

<sup>2</sup> Changes could also be observed at a governmental level. In 1963, the governments of France and Hungary were the first to provide subsidies for the conservation of local breeds.

breeds, and thus in conservation”, says John Hogdes. “Mason came as Animal Breeding Officer to the FAO in 1972. He had already started the documentation of breeds in the 1940s, and then carried on making his filing cabinet at the FAO, collecting breed data from Africa, Asia and Latin America”. Referring to the same period, Edward Rege (Kenya) notes: “Although the question ‘Is new germplasm successful in a traditional environment?’ had arisen, still no action was undertaken in the form of new policies”.

In 1974, in conjunction with the United Nations Environment Programme (UNEP) that was born at the 1972 Stockholm Conference, FAO launched the project “Conservation of animal genetic resources”. Over a period of six years, extensive surveys were carried out to describe the status of local breeds in a wide range of world regions, while a few studies were initiated with the aim to develop methodologies for conservation and management.

In the meantime, an important conference was organised in 1974 by the International Committee for World Congresses on Genetics Applied to Livestock Production. It was the first World Congress organised by the Committee and “the first opportunity for scientists to discuss the genetics of farm animal breeding and breed conservation at an international level”, explains Stuart Barker. Genetics was a new tool in breeding programmes. “At that time”, says David Steane (United Kingdom), “we knew how to improve the traits of interest in breeding, but no-one knew which genes and – more importantly – which gene-combinations to save for the future”.

At the end of the first FAO/UNEP cooperation, a joint Technical Consultation on Animal Genetic Resources, Conservation and Management (1980) was organised. The Consultation took place in Rome and represented a turning point in AnGR management. The alarming results from the surveys of endangered breeds, together with the growing understanding of genetics and the recent fruitful efforts at different levels in society to conserve local breeds, finally provided the impulse to convince governments of the need to conserve AnGR. Poultry- expert Roy Crawford: “The effect of the 1980 Consultation was huge. People were first thinking alone. This conference was a landmark, as it provided an opportunity to create international liaisons”.

The meeting in 1980 embodied the second milestone in AnGR history. Lawrence Alderson: “The Consultation was the biggest milestone in terms of going forward. It drew everyone together; it created friendships between NGOs and governments.”

## The third milestone: ‘sustainable use of biodiversity’

“We struggled for the inclusion of agrobiodiversity in the Convention on Biological Diversity (CBD) but we got help from the powerful “Business Council for Sustainable Development””, tells Hans-Peter Grunenfelder. The CBD was signed in 1992 by 150 government leaders at the Rio Earth Summit.

The recommendations of the 1980 Technical Consultation (FAO, 1981) finally provided a response at policy level to the long-standing issue of displacing native breeds and crossbreeding them with a few highly-selected breeds. Following the recommendations, a Joint FAO/UNEP Project for Conservation and Management of Animal Genetic Resources was set up. Coordinated by John Hodges at FAO from 1982 till 1990, the project laid the foundations for a worldwide infrastructure for AnGR conservation (Hodges, 2002). Although the project was largely supported by UNEP, “funding was limited”, says Hodges. Practical guidance came from a Panel of Experts from UNEP and FAO who gave technical advice about a new approach to the global management of AnGR.

Major developments in AnGR conservation were published in FAO’s Animal Production and Health papers. “These papers were the ‘bible’ for us in Brazil”, says Arthur Mariante, “They are still used as a reference by our students nowadays”. Information on conservation projects and studies around the globe were published (and are still being published) in the FAO Animal Genetic Resources Information Bulletin (AGRI) since 1983. After John Hodges, Jean Boyazoglu (Greece), Daniel Chupin (France), Salah Galal (Egypt) and Ricardo Cardellino (Uruguay) served as its editors, and AGRI continues to be the only journal of its kind.

In Europe, conservation activities were boosted in 1980 by the European Association for Animal Production (EAAP). EAAP set up a European Working Group on Animal Genetic Resources (WG-AGR) which initiated surveys of European

---

<sup>3</sup> The Business Council for Sustainable Development (BCSD) was founded in 1991 by the Swiss industrialist Stephan Schmidheiny, and is now called the World Business Council for Sustainable Development (WBCSD).

breeds and populations in 1982. Five years later, the survey data could be entered in a novel electronic databank that was created by Detlef Simon. In close cooperation with FAO, the Hannover databank began storing world data on AnGR in 1988, until their transfer to FAO in 1991. This transfer provided the starting point for the FAO database for AnGR, the backbone of the Domestic Animal Diversity Information System or DAD-IS (now in its third version). Consequently, the Hannover databank was renamed EAAP Animal Genetic Data Bank and provided the first information on AnGR at regional level.

Another emerging NGO partner of FAO – at a global level – was Rare Breeds International (RBI), established in 1991. *“Lawrence Alderson gave the initial push on behalf of the RBST. Other people, including John Hodges, Imre Bodó, Arthur Mariante and myself, continued the work”*, recounts Roy Crawford. The funding and facilities of RBI were meagre: *“The secretariat was at my lunch table in Canada”*. Nevertheless, the organisation would become a common voice for the increasing number of national and regional bodies interested in conserving rare livestock breeds. Keith Ramsay (South Africa): *“While FAO had a network at a governmental level, RBI was important for creating liaisons at grassroot level”*.

While the international network of governments and NGOs kept on growing, the concept of ‘sustainability’ (Brundlandt, 1987) was getting a firmer grip on society. As a result, the UN planned the Conference on Environment and Development (UNCED) or ‘Rio Earth Summit’ in 1992 to incorporate this concept in global environmental programmes. In line with the aim of Agenda 21 – a global partnership for sustainable development – three conventions were adopted soon after the Rio Earth Summit. One of them was the Convention on Biological Diversity (CBD).

The impact of the CBD was tremendous. On the one hand, it was a large leap forward for the conservation and sustainable use of natural resources in general. On the other, however, the Convention was a disappointment for the AnGR movement, as it lacked a specific framework for AnGR conservation. This might seem detrimental; yet the consequence was surprisingly positive. Lawrence Alderson compares it with the effect of the disease outbreaks that occurred later in the 1990s and at the beginning of the 21st century: *“The CBD had the same impact as disease epidemics like BSE and food-and-mouth disease. The fear of losing breeds served as a powerful trigger for people to react.”*

The CBD was thus the third milestone in the global evolution of AnGR management.

## Passing on the fire – time for action

David Steane: *“Perhaps the biggest challenge is now to raise awareness in order to get funds”*. He adds: *“I doubt if nations really can keep all breeds but we do need to maintain the overall genetic diversity”*.

*“It is the livestock keepers who will always be the main actors in the conservation and sustainable use of all our animal genetic resources – without a diversity of livestock keepers, it will not be possible to maintain livestock diversity. Their needs have to be recognized by policy makers, researchers, and even consumers”* says Ilse Köhler-Rollefson of the League for Pastoral Peoples and Endogenous Livestock Development.

In 1990, the FAO Council recommended the preparation of a comprehensive programme for the sustainable management of animal genetic resources at the global level. In the years following the signing of the CBD the global infrastructure was extended further by FAO, at both national and regional levels. In an FAO Expert Consultation on Management of Global Animal Genetic Resources in 1992, this programme took shape. Supported by the Deputy Director General Philippe Mahler (France) and the Division Director Patrick Cunningham (Ireland), Keith Hammond played a key role in initiating the Global Strategy for the Management of Animal Genetic Resources in 1993, with the aim of supporting countries in developing and implementing national management strategies for AnGR. In 1995, the FAO Commission on Plant Genetic Resources for Food and Agriculture widened its mandate to include also AnGR and became the Commission on Genetic Resources for Food and Agriculture (CGRFA). It established an Intergovernmental Technical Working Group on Animal Genetic Resources in 1997. FAO thus further established its role as *the* intergovernmental technical secretariat for food and agriculture.

Following efforts of the CGRFA, AnGR experts and civil society, the CBD supported the further development of the Global Strategy in 1996<sup>4</sup> and

<sup>4</sup>Decision III/11 [www.biodiv.org/decisions/default.aspx?dec=III/11](http://www.biodiv.org/decisions/default.aspx?dec=III/11)

<sup>5</sup>Decision V/5 [www.biodiv.org/decisions/default.aspx?dec=V/5](http://www.biodiv.org/decisions/default.aspx?dec=V/5)

established a work programme on agricultural biodiversity in 2000<sup>5</sup>.

The first Regional Focal Point (RFP) for the management of AnGR was set up in Asia with Japanese funding, and managed by David Steane and his Asian colleagues. After six years, in 1999, this pioneering project was forced to end as funds were no longer available. Another Sub-regional Focal Point was established for the SADC region in South Africa but it, too, did not endure after project funds dried up. In contrast, the intensive collaboration of FAO and EAAP, with public support at hand, led to the establishment of a vast network of National Focal Points (NFP) in European countries, until a European RFP was launched in 2000. This regional platform, managed by Dominique Planchenault in Paris, is the first example of a RFP supported by the region itself. Unfortunately, very few RFPs have so far emerged elsewhere in the world, mainly due to the lack of the necessary regional support.

The participation of NGOs and research organisations in AnGR management continued to increase during the 1990s. The EAAP WG-AGR still provided valuable scientific input during FAO consultations. Other research organisations, i.e. the International Livestock Research Institute or the International Society for Animal Genetics, NARS and new national and international NGOs also joined the AnGR movement. FAO's work improved considerably: "*Various international NGOs continued to contribute (...) and a small number were given observer status at the intergovernmental sessions of FAO governing bodies<sup>6</sup>, the CGRFA and its Intergovernmental Technical Working Group on Animal Genetic Resources*", says Keith Hammond (Australia). Furthermore: "*A larger number of international NGOs supported the development of FAO's work program by contributing to the negotiation of AnGR issues at sessions of the Conference of Parties to the CBD*". Moreover, as national governments and regional bodies became more aware of the state of AnGR, research programmes saw a slow increase in available funds and rare breeds got more support.

Meanwhile, the cataloguing of breeds by FAO was still going on and resulted in the first World Watch List for Domestic Animal Diversity in 1993. The FAO database and information system DAD-IS (1996) became the primary tool to exchange breed data and know-how on AnGR management. In addition to the collection of breed data, FAO initiated the first global assessment of AnGR. Countries were invited in 2001 to prepare their Country Reports on the status and trends of AnGR, and of the state of institutional and technological

capacities to manage these resources. In 2002, the CBD decided to support this ambitious undertaking<sup>7</sup>.

Now, fifteen years after the Rio Earth Summit, we have a comprehensive overview of *The State of the World's Animal Genetic Resources for Food and Agriculture* (SoW). This report builds on Country Reports from 169 countries – the fruit of many national governments and stakeholders – and the work of civil society and research institutions. Again, collaboration with an NGO, the World Association for Animal Production and its then Secretary-General Jean Boyazoglu, was essential for FAO in the SoW preparation process. At FAO, Keith Hammond played a key role in making the issues known worldwide, and Ricardo Cardellino and Pal Hajas were pivotal in persuading governments to develop Country Reports. The SoW has been adopted in June 2007 by the CGRFA and will be presented in September this year during the Technical Conference. We do not know everything, but the message of the SoW seems clear: diversity means resilience – we should promote it!

One of the expected outcomes of the September Conference will be a *Global Plan of Action for Animal Genetic Resources*. Whatever this plan will look like, it is clear that finding appropriate support will be crucial. Raising public awareness, therefore, remains a key priority. Another priority is to further develop infrastructures and pass on skills for AnGR management. Keith Ramsay: "*We should create more regional focal points and improve the international communication through FAO forums*". Creative solutions are also required to promote and conserve local breeds. "*Developing value-added products is a good way to draw attention to the uniqueness of local breeds*", says Ramsay. The colourful hides of N'guni cattle in South-Africa and the camel milk ice cream of India are fine examples of such products. Apart from these two priorities, many other issues will have to be addressed to agree on a meaningful and executable *Global Plan of Action*.

We have learned that the first passionate efforts to use and conserve AnGR in a sustainable way have arisen at the grassroots' level – by people who depend on them in their daily lives, or by people who simply care about them. Ilse Köhler-Rollefson "*Many important breeds are conserved against the odds by people who are poor and marginalized, but who have*

---

<sup>6</sup>The FAO Commission on Agriculture (COAG) and the FAO Council.

<sup>7</sup>Decision VI/5 [www.biodiv.org/decisions/default.aspx?dec=VI/5](http://www.biodiv.org/decisions/default.aspx?dec=VI/5)



a close cultural and emotional attachment to their animals." Roy Crawford: "It would help if the grassroots could be more actively involved in governmental programs – to provide the spark and fire the passion". The most important matter now is to create a broader movement, and an enabling and supportive policy framework for AnGR management. "We need joint forces of the government, the NGO and the university side to keep AnGR", says Hans-Peter Grunenfelder, "Joining forces we will succeed!". Indeed, we must make sure that the fire is passed on, till we reach the next milestone – the Technical Conference, together with a *Global Plan of Action* – and the many milestones that will follow.

The fire is crucial for AnGR. For natural disasters it is easy to show the need for immediate action; for protecting agricultural plant diversity it is already more difficult. For farm animals it is even harder to prove the urgent need for conservation. It requires creativity to further catch the public eye and conserve the indispensable diversity of AnGR. Kalle Maijala: "It is not easy for most people to understand, but I hope, that positive development continues gradually."

Crawford concludes: "I caught 'the fire' many decades ago, and have devoted my professional and retirement life to tending the blaze. The fire does NOT go out it seems!"

Before ending this paper, the authors would like to state that the fire not only exists in the hearts of the experts from grassroots, research or government level we have interviewed. During the past 12 000 years, livestock keepers worldwide had the most important role in the history of animal production. They have been and continue to be the people responsible for the evolution, improvement and safeguarding of the rich diversity of livestock breeds we have today, for all the different production systems and intensity levels. Therefore, we should learn from these very livestock breeders and keepers how to use in sustainable way and conserve our AnGR, and carry the fire together with them.

## Acknowledgements

We would like to warmly thank all the AnGR experts who were interviewed for the purpose of this paper.

## List of References

- Brundlandt, G. (Ed.).** 1987. Our Common Future: The World Commission on Environment and Development; <http://ringofpeace.org/environment/brundtland.html>.
- FAO.** 1945. Constitution of the Food and Agriculture Organisation of the United Nations. Quebec, 16 October 1945.
- FAO.** 1967. Report of the FAO study group on the evaluation, utilization and conservation of animal genetic resources. Meeting Report 1966, 9, Rome, pp. 31.
- FAO.** 1990. Animal genetic resources. A global programme for sustainable development. Proceedings of an FAO Expert Consultation Rome, Italy, September 1989. FAO Animal Production and Health Paper 80.
- FAO.** 2007. The State of the World's Animal Genetic Resources for Food and Agriculture, Barbara Rischkowsky & Dafydd Pilling (Eds). Rome, Italy.
- Hodges, J.** 1999. Jubilee History of the European Association for Animal Production 1949-1999. Livestock Production Science 60, 105-168.
- Hodges, J.** 2002. Conservation of farm animal diversity: history and prospects. AGRI 32, 1-11.
- Mason, I.** 1981. Cooperative work by FAO and UNEP on the conservation of animal genetic resources. In: FAO: Animal Genetic Resources Conservation and Management. FAO Animal Production and Health Paper 24, 15-28.
- Philips, R.W.** 1981. The identification, conservation and effective use of valuable animal genetic resources. In: FAO, 1981. Animal Genetic Resources Conservation and Management. FAO Animal Production and Health Paper 24, 1-5.



## Randall cattle in the USA: rescuing a genetic resource from extinction

D.P. Sponenberg<sup>1</sup>, C. Creech<sup>2</sup> & W.J. Miller<sup>3</sup>

<sup>1</sup>Department of Biosciences and Pathobiology, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA 24061, USA

<sup>2</sup>59 Ore Hill Road, South Kent, CT 06785, USA

<sup>3</sup>218 Parkridge Circle, Ames, IA 50014, USA

### Summary

Randall Cattle are a landrace from the northeast USA. The cattle are triple-purpose and well adapted to the cold northeast geographic region. The current population descends from 14 cattle that remained after the death of the original owner, though only 12 of these represented unique founders due to interrelationships among the 14. He had kept the cattle as an isolated strain for nearly 80 years. Blood-typing results point to a north Atlantic origin for the breed, which is consistent with the history. The policy and practice of the American Livestock Breeds Conservancy has been to carefully document landraces and to assure their conservation. Focused breeding strategies have succeeded in rescuing the original 13 animals and expanding the population to nearly 300 in 2006. The breed is gaining popularity as a hardy, adapted and useful genetic resource. Breeding management has decreased overall inbreeding while at the same time managing the contributions of the various founder animals.

### Résumé

La race "Randall" est une race locale du Nord-Est des Etats-Unis. Il s'agit d'une race a triple propos et elle s'adapte bien à cette région froide. La population actuelle s'est formée à partir des 14 animaux découverts après la mort de leur propriétaire qui avait conservé son troupeau isolé pendant plus de 80 ans. Le type de sang révèle une origine de la race proche au bovins de la région Nord Atlantique, ce qui coïncide avec l'histoire de cette race. La "American Livestock Breeds Conservancy" a établi un document détaillé des races locales pour s'assurer qu'elles ne disparaissent pas. Grâce aux stratégies d'élevage

du noyau initial on est arrivé à 300 têtes en 2006. La race est appréciée surtout en tant que race rustique, bien adaptée et utile. La gestion de la population a permis la diminution de la consanguinité tout en assurant l'apport de chacun des animaux d'origine. Cette race est en augmentation et son futur est assuré.

### Resúmen

La raza "Randall" es una raza local del nordeste de los Estados Unidos. Se trata de una raza de triple-propósito, bien adaptada a esta región fría. La población actual se fundó con 14 cabezas descubiertas después de la muerte del dueño original que había mantenido su ganado aislado durante unos 80 años. Los tipos de sangre colocan el origen de la raza en los bovinos de la región nordatlántica, lo que corresponde con la historia de la raza. La "American Livestock Breeds Conservancy" ha documentado las razas locales para asegurar que no se extingan. Las estrategias de cría han tenido éxito en el rescate de las 13 cabezas originales, y la cabaña ha aumentado hasta 300 cabezas en 2006. La raza es popular como raza rústica, bien adaptada, y útil. El manejo de la población ha disminuido la consanguinidad, pero asegurando la contribución de cada animal fundador. El número de animales de esta raza está ya creciendo y el futuro está asegurado.

**Keywords:** Local breed, Description, Original herd, Breeding management, Blood-typing, Breed expansion, Conservation.

## Introduction

Animal production and breed use in the United States of America is typical of most industrialized countries (Rouse, 1973; Sims and Johnson, 1972), with the exception that direct governmental regulation of breeding and monitoring of populations is minimal. For most of the past century livestock production has been based on imported, well documented purebred livestock registered in herd books that are maintained by non-governmental breed associations. In addition, composite breeds based on pure breeds were later developed in an attempt to combine attributes of various founder breeds into new mixtures designed for specific environments or production situations. A final and recent stage of breed development has been industrial strains of livestock, mainly swine and poultry which are designed to be very productive in tightly controlled environments. Industrial strains are based on pure breeds originally, but have usually functioned outside of the purebred livestock community because of their strictly industrial function and their lack of participation in associations or herd books.

A few older and more traditional livestock production systems have persisted peripheral to these mainstream systems. These older types of livestock tend to be overlooked by both governmental programs and scientific investigators, largely because these systems and their animals are considered to be of low productivity and are outside the usual short-term commercial concerns of mainstream American agricultural production. Traditional livestock have, however, persisted in sustainable systems, and are well adapted to harsh and demanding environments, and are therefore genetic resources of potential future utility.

The livestock of peripheral, sustainable systems includes old types that continue to persist in genetic isolation from other livestock genetic resources. The American Livestock Breeds Conservancy (ALBC) is actively engaged in saving the livestock genetic resources of these systems. ALBC is a nongovernmental nonprofit organization that serves an important role as a central source of information, procedures, practices, and technical support for breeders of rare livestock genetic resources. ALBC classifies populations of isolated, traditional livestock as landraces, and has developed procedures for their identification, classification, and conservation (Sponenberg and Christman, 1995). Randall Cattle are one such American landrace, and the rescue of this population from extinction has provided the ALBC

with many insights that have been useful in developing strategies and procedures for working with other small populations of livestock (Christman and Sponenberg, 1997).

## History

Well-adapted triple purpose (milk, meat, draft) cattle have been useful in the northeast of the United States for centuries. These cattle were introduced to the region during early colonization by Europeans, and were widely used for production in this region of cold winters, short summers, steep slopes, and poor, rocky soils. One genetic resource that was commonly used was the widely recognized Milking Devon, an isolated type within the more widespread Devon breed (Splan and Sponenberg, 2004). This type is now limited to the United States (Christman and Sponenberg, 1997). Other cattle types within the same region have occurred for centuries, but these others have lacked breed identification and have lagged behind the Milking Devon in breed recognition and conservation programs (Rouse 1973).

One reasonably common type within New England was called '*Linebacked Cattle*'. These cattle were generally black but occasionally red, and had either the colour-sided pattern or '*Pinzgauer*' pattern, either of which is characterized by a distinctive white top-line that gives the cattle their name. Various strains of Linebacked cattle existed, although throughout the 1960s and 1970s they were increasingly crossbred with Holstein cattle to provide higher milk production. Through this slow genetic erosion, nearly all of this type of New England landrace cattle became extinct. In 1986 Everett Randall's herd of Lineback cattle came to the attention of the livestock conservation community. He had kept his herd free from other breeds for nearly 80 years, but with his death the herd's future was in peril.

The Randall cattle went from Everett Randall's estate to a few different buyers. One of these original buyers, a single breeder (C. Creech) became the owner of the vast majority of them, and embarked on a breed rescue and conservation program which has resulted in a growing population of Randall cattle that are now secure as an adapted genetic resource. Two other early breeders obtained a few of the dispersed cattle, and while most of those were lost to the conservation effort, a few have made important contributions to the conservation of the population. Procedures and practices that were developed in the course of rescuing and conserving

the Randall cattle have been essential to their survival as well as helping in the conservation of other rare livestock breed resources.

## Description

Randall cattle are moderate but variable in size, and have a type that varies from predominantly dairy to dual-purpose. Mature cows vary from 300 kg to 400 kg, with a few outside of this range. The types within the breed cluster around one that most resembles older Shorthorn type, and others that are more similar to Channel Island breeds such as Jersey and Guernsey. Very few of the animals show a heavier beef type. The range of types is in keeping with the long selection history of use in low-input subsistence dairying. All of the cattle are horned, and the horns are generally short and spread out and upward. A few have horns with a more inward twist. Udders are generally medium-sized with good attachments and medium sized teats.

The color of all of the original remnant cattle was consistently black, with all animals having the 'color-sided' pattern of white spotting. The color-sided pattern within this herd varies from very dark to nearly white. At the dark extreme are animals with only a minimally white top-line and underline and no roaning. In most, however, the head and edges of the white areas are generally roan or speckled even in the darkest individuals, which produces a 'blue' appearance and led to another synonym of 'Randall Blue' for the breed. The palest animals have pale roan sides, with extensively white top-lines and underlines. In the palest animals, dark areas characteristically remain on the muzzle, ears, feet, around the eyes, and there is generally a dark spot on the forehead. In between the dark and pale extremes of color pattern are animals that are distinctly line-backed, but with roan and speckled areas especially where colored and white areas meet. These are illustrated in figures 1 and 2.

In recent years red-based animals have emerged in the herd. These were reported to be in the herd in early years, and the color has persisted as a recessive allele. The red animals have the same distinctive range of expression of the color-sided pattern as do the black animals.

## Foundation Population

The original herd presented for conservation consisted of four bulls and nine cows. The herd was examined for age structure as an aid to determining relationships. Everett Randall had used single sires for most of the previous 80 years, so that age-mates were likely to be half siblings. This logic determined that the initial group included five cows and a bull that were likely all sired by the same bull, who was no longer living. These five cows were assumed to be out of different dams. This assumption was especially valid for the animals with the same birth year (one pair of cows from one year, a cow and the mature bull from a second year, and a single cow from a third year).

Also included in the herd were four younger cows and two younger bulls sired by the living mature bull. Dam information was present for this younger group, and only one of these (a cow) was produced by a cow not present in the older group. The other three had been produced by dams that were in the older group. The final young bull calf was produced by one of the younger bulls and an older cow otherwise unrepresented and unavailable for the conservation effort.

The animal pedigree information was used to create a spread sheet that enabled tracking of the population. Specific information that was tracked included sex, year of birth, sire, dam, and the contribution to the animal from each of the founders.

## Breeding Management

The relationships among the founders and their descendants were used to design a breeding program that followed a few general principles. The goals of the breeding program varied for different matings. Most matings attempted to minimize inbreeding, in an effort to reduce the risk of inbreeding depression in what was already an inbred population.

In contrast, a few specific matings were constrained to produce line-bred offspring that concentrated the contribution of each of the specific founders. This strategy produced cattle each of which was a high percentage of one of the founders. The goal for this strategy was especially to provide bulls from which semen could be frozen as an



Figure 1. Randall cows with a lighter manifestation of the color-sided pattern.

insurance against the loss of certain lines within the population. This was important as freezing of semen is relatively inexpensive compared to other assisted reproduction techniques, and in the absence of governmental subsidy or support attention needed to be paid to the economic aspects of the breed rescue.

The inbreeding strategy was used as an attempt to ensure that some individuals, though highly inbred, would be high percentage specific founders, and would therefore be less distantly related to most other animals in the population. These line-bred animals could then be used over large numbers of other animals in the breed to produce more out-bred offspring that still retained significant influence of the various founders but without significantly high inbreeding. This would have been impossible if a strategy of uniformly reducing inbreeding had been used to guide all mating decisions, and the risk of loss of the distinctive contributions of the various founders would have been greater by following that strategy.

Breeding management was also deliberately changed from the original single-sire system. It is common in the USA for landrace herds to use a single sire for multiple years, and then to replace him with a son. A new and more genetically sound strategy was developed, so that multiple bulls were

used (generally no fewer than two per year) and each bull tended to be used for only a single year. The result was a more rapid turnover of males, and by that means an avoidance of the genetic bottleneck that males can easily present to a small population.

Semen was frozen on individual males that were either foundation animals, or that had high percentages of the breeding of individual foundation cows. This strategy provided for the availability of this genetic material for the future of the breed, and especially served to provide the genetic material of the founders in a readily accessible form (semen versus oocytes or embryos) that was economically feasible.

The consequences of the breeding management decisions can be appreciated in table 1. A few of the founders, such as the sire of the majority of the original animals, were bottlenecks to the population. The percentage contribution from various founders ranges from 35% to 0.9%. Of more importance to the long term survival of the population is the range in percent contributions of the various founders. It is clear that the influence of Founder 1 (the sire of the original older group) will never be minimized to a proportionate contribution because no animal lacks his influence. He is the bottleneck to the population. Other founders have

minimal or no contribution to at least some animals in the population. This allows, at least for that one founder, the planning of matings to counteract any overrepresentation (inbreeding) to that one founder.

Some founders, usually by virtue of contributing to only one individual early animal, will never have the potential to contribute much to the overall population. Examples are Founder 8 and Founder 10, with the maximal representation of 19% and 13% respectively in any individual animal in the population. For others, such as Founder 12, the minimal overall contribution can be countered by using a relatively high percentage bull across several animals. Founder 12's contribution comes from one of the bulls used in a smaller herd away from the main conservation herd. Fortunately semen is available, and this provides an opportunity to manage this founder's contribution and to provide for its inclusion across broader portions of the breed.

Most of the founders are represented by animals that have at least 25% of the genetic influence of the founder. Semen from such animals has been frozen where possible. In some cases these high percentage animals are females. In those cases the strategy has

had to shift to planned matings that increase line-breeding to the high percentage founder. The goal of these matings is to produce bulls that are a high percentage of the founder and that can have semen frozen for future representation of that founder.

## Blood-typing

Conventional blood-typing of the population was accomplished at a relatively early stage in the conservation program in an effort to determine relationships among the founders as well as possible breed origins of the population.

Blood-typing of the population (17 animals) was done in 1992, and the results are shown in table 2. The results of the blood-typing indicate low variability at many loci, which is consistent with the long history of isolation of this population. One locus remains highly variable, B, at which many alleles remain.

The specific variants that are present point to a north Atlantic origin for Randall cattle, which is consistent with the history of the region in which



Figure 2. Randall cow with a mid-range manifestation of the color-sided pattern, and with a pale calf at foot.

Table 1. Management of percentage contributions of founder animals through breeding management.

Founder	Average % of all cattle	Average % in cattle alive in 2005	Target % for long term management	Minimum % in cattle alive in 2005	Maximum % in cattle alive in 2005
1	35	33	30	12	48
2	16	16	11	0	50
3	15	15	11	2	25
4	5.7	5.7	6	0	38
5	7	7	6	0	25
6	4	4	6	0	50
7	5.9	5.9	5	0	25
8	2.8	2.5	5	0	19
9	4.3	4.6	5	0	25
10	2.8	2.4	5	0	13
11	2	2.1	5	0	25
12	0.9	1.5	5	0	50

Table 2. Blood-types within the Randall cattle herd.

Locus	Allele	No.
A	A1	20
	A1H	2
	A1DH	5
B	01	9
	I103J'K'O'	4
	E'3	5
	B28	9
	PQI'	2
	I'	3
	E'3G'	1
	I1	1
C	C2EW	8
	R1WX2	2
	C2EWX1	1
	L'	1
	R1X1	1
	C2EWX2	1
	EWX2	1
	EW	3
	E	1
	F	F
V		4
J	J	11
	-	14
L	L	13
	-	10
M	1	34
S	SH'	all
Z	Z	5
	-	24
	Z2	1
R	S'	11
	R'S'	7



they were found. Specific variants found in the population are also found in Holstein, Jersey or Guernsey, and Shorthorn cattle. A few, such as I1O3J'K'O' are rare in all other breeds, and indicate the antiquity and uniqueness of the Randall cattle.

Specific blood-typing results indicate that only eight B pheno groups were found in the 17 samples, including the rare I1O3J'K'O' type, represented by four copies in the population, and in every case were heterozygous. The A system shows a few type D, with many homozygous for its absence. The S system is non-variable in this population, as all are SH'. An older reagent, the 'Wisconsin' reagent was negative in two animals, and is noteworthy because the reagent is rarely non-reactive.

The blood-typing results are interesting in that several loci reflect the history of closed breeding within a small herd. Even though several loci have minimal variability, others have retained great variability. Singh and Nordskog (1981) suggest, after detailing similar findings in inbred lines of chicken, that certain loci may retain variability in inbred populations due to their role in fitness and adaptability.

Landraces are notoriously difficult to define, and ALBC has found that blood types or DNA fingerprinting can greatly aid in landrace definition. This is especially the case for decisions as to inclusion or exclusion of individual animals. Blood-typing of the Randall cattle was useful in determining the legitimacy of one bull which had passed through multiple owners before being rediscovered as a potential Randall animal. His history raised some doubts about his relationship to the breed, but blood-typing showed that he was indeed of the breed and a useful founder animal.

## Strategies for Breed Expansion

As a result of the targeted rescue and conservation work, the breed received publicity through the ALBC. This was accomplished through the ALBC newsletter, as well as through the network of individuals that characterizes the active breeder members of ALBC. The initial phase of the rescue was accomplished with very few breeders, so that a formal breeder organization was not essential. As animals were sold into an increasing number of herds, the breeders organized a breed association, and formalised the registration and documentation of animals within the breed.

The breed is now finding demand as a low-input subsistence animal suited for home dairy production, as well as for the production of beef. In

addition, excess males find a ready market in a small but strong demand for oxen. Their aptitude for draft is high, as they are active as well as willing, and those using the oxen specifically note that they are very quick to learn. The organization of breeders as well as the increased availability of animals has resulted in a demand for the breed that assures breeders of a consistent market for breeding animals as well as for oxen. This has all been accomplished by diligent work on the part of the non-governmental sector. The breed is numerically still very rare, and it will take several years of expanding numbers before it becomes a mainstream production breed. It has, however, found a secure if small niche in American agriculture, so that numbers are increasing rather than decreasing. It is therefore very unlikely to face a census crisis or danger of extinction.

## Discussion

Rescue of the Randall cattle from the very doorstep of extinction has provided the ALBC with useful experience in working with a 'worst case' situation where a numerically rare livestock genetic resource has needed careful strategies for breeding and population management to avoid its outright extinction (through sale to slaughter) as well as a slower extinction through inbreeding depression. The lessons learned have had wide ranging repercussions for the conservation of traditional livestock genetic resources, especially in view of the lack of direct governmental support and oversight for conservation programs in the USA. Developed countries such as the USA present special challenges for the conservation of traditional, adapted livestock because these resources differ from the usual breeds of interest which are selected for immediate commercial utility.

It is important to note that landraces still persist in developed countries, but are very likely to be overlooked in organized conservation efforts due to their poor documentation. Landraces tend to fall from notice when compared to standardized breeds with active breed registry organizations, and this is especially the case when governmental agencies and non-governmental entities focus only on the more readily identifiable standardized breeds with well-developed breed associations that advocate for their breeds. In this situation it becomes all too easy to conclude that if there is no breed association, then there is no breed.

In the USA, no other strain of landrace cattle from New England has survived to be available for

conservation work, despite the anecdotal persistence of several of these up until the 1970s or 1980s. This unfortunate fact is due to the long practice of ignoring landraces as legitimate genetic resources. The success of the conservation of Randall Cattle stands in contrast to a more general failure to conserve related strains of this overall type of cattle that would have provided greater genetic diversity within this type of cattle.

Randall cattle illustrate the successes that can be experienced with small populations that are fortunate enough to have caretakers that are dedicated to their survival. Most of the Randall cattle recovery has been due to a single breeder (C. Creech) functioning as a private individual with no governmental support. Importantly, contributions from a few of the original animals that remained outside of this main conservation herd have also been essential for the conservation of these cattle, usually because these animals represented a diversity absent from the main conservation herd. Fortunately for the breed, many other breeders are now contributing to its survival and its genetic management.

Randall cattle serve as a reminder that while inbreeding depression is a threat to breed conservation, not all inbred populations decline from depression. While a few cows have had reproductive failures, the majority of the cattle remain fertile and have good health. Managing the levels of inbreeding is clearly an important priority, and requires carefully constructed breeding plans and population-management procedures. The easier solution in the face of such small numbers is to resort to crossbreeding, but this strategy only

assures the premature loss of important adapted genetic resources.

## List of References

**Christman, C.J., D.P. Sponenberg & D.E. Bixby.** 1977. *A Rare Breeds Album of American Livestock*. The American Livestock Breeds Conservancy. Pittsboro, North Carolina.

**Rouse, J.E.** 1973. *World Cattle III: Cattle of North America*. University of Oklahoma Press. Norman, Oklahoma. 1973.

**Sims, J.A. & L.E. Johnson.** 1972. *Animals in the American Economy*. The Iowa State University Press. Ames, Iowa.

**Singh, H. & A.W. Nordskog.** 1981. Biochemical Polymorphic Systems in Inbred Lines of Chickens: A Survey. *Biochemical Genetics* 19: 1031-1035.

**Splan, R.K. & D.P. Sponenberg.** 2004. Characterization and Conservation of the American Milking Devon. *Animal Genetic Resources Information* 34: 11-16.

**Sponenberg, D.P. & C.J. Christman.** 1995. *A Conservation Breeding Handbook*. The American Livestock Breeds Conservancy. Pittsboro, North Carolina.

# Puesta en valor de un sistema tradicional y de sus recursos genéticos mediante una Indicación Geográfica: El proceso de la Carne Caprina del Norte Neuquino en la Patagonia Argentina

M. Pérez Centeno<sup>1</sup>, M.R. Lanari<sup>2</sup>, P. Romero<sup>1</sup>, L. Monacchi<sup>1</sup>, M. Zimmerman<sup>2</sup>, M. Barrionuevo<sup>1</sup>, A. Vázquez<sup>5</sup>, M. Champredonde<sup>3</sup>, J. Rocca<sup>1</sup>, F. López Raggi<sup>4</sup> & E. Domingo<sup>2</sup>

<sup>1</sup>Instituto Nacional de Tecnología Agropecuaria, AER Chos Malal, Argentina<sup>1</sup>,

<sup>2</sup>Genética en Rumiantes Menores, Area de Producción Animal, INTA EEA Bariloche, San Carlos de Bariloche, Paraje Valle Verde S/N CC 277 (8400), Río Negro, Patagonia, Argentina

<sup>3</sup>INTA EEA. Bordenave CC Nro. 44 - 8187 Bordenave, Buenos Aires, Argentina

<sup>4</sup>Fac. Economía UNCo, Argentina

<sup>5</sup>Dirección de Ganadería de la Prov. del Neuquen, Argentina

## Resumen

El sistema tradicional de producción caprina del norte de Neuquen (Patagonia, Argentina), desarrollado por "crianceros" trashumantes, es un sistema marginal de baja dotación de recursos económicos y alta fragilidad ambiental pero que dispone de un alto capital cultural, un recurso genético adaptado y un producto de calidad superior reconocida pero no diferenciado. A fin de superar esta situación se propone la aplicación de una Denominación de Origen (DO). La propuesta se basó en la organización de los integrantes de la cadena de valor de la carne caprina regional y la determinación de sus cualidades tecnológicas ligado a la raza Criolla Neuquina. Se construyó una visión común sobre el sistema y su identidad, expresada en el Protocolo de la Denominación de Origen del "Chivito Criollo del Norte Neuquino". Los estudios sobre la tipicidad y calidad han permitido establecer indicadores de la misma y la trazabilidad del producto. El fortalecimiento de las organizaciones campesinas y la conformación de un espacio de articulación ha permitido niveles de concertación inexistentes hasta el presente que potencian el desarrollo del territorio y lo capitalizan, dando proyección a la sostenibilidad del sistema y del recurso genético.

## Summary

The traditional goat production system from North Neuquen (Patagonia, Argentina), developed by transhumant goat keepers is a marginal system with low economic input and fragile environment but with a high cultural capital, an adapted genetic

resource and a product with high reputation but not differentiated. To overcome this situation the application of a Geographical Indication was proposed. This process was based on the organization of the local goat meat marketing chain and the description of technological properties of the product of the Neuquen Criollo breed. The chain actors have constructed a common vision about the system and its identity, which is reflected in the Protocol of the Designation of Origin of the "Criollo Kid of North Neuquen". The study on product's typicity and quality has contributed to define quality indicators and traceability of the product. As a result Goat Keepers organizations have been empowered, a common ground of communication has been established enhancing the understanding level among local actors, which was previously not existent. This has reinforced regional development and given projection to system and genetic resource sustainability.

## Résumé

Le système traditionnel de production caprine dans le Nord du Neuquen (Patagonie, Argentine), développé par les "crianceros (éleveurs)" transhumants, est un système marginal à faible input en ressources économiques et grande fragilité environnementale, mais qui dispose d'un capital culturel élevé, une ressources génétique adaptée et un produit de qualité supérieure reconnu mais non différencié. Pour améliorer cette situation on propose la demande d'une Dénomination d'Origine (DO). La proposition se base sur l'organisation des différentes parties de la chaîne de valeur de la viande caprine dans la région et la définition de ses

qualités technologiques liées à la race Criolla Neuquina. On a élaboré un plan commun sur le système et identité recueilli dans le Protocole de la Dénomination d'Origine du "Chivito Criollo del Norte Neuquino". Les études sur la typicité et la qualité ont permis d'établir des indicateurs de la race et la traçabilité du produit. Le renforcement des organisations d'éleveurs et la l'établissement d'un espace ont permis des niveaux d'accord inexistantes auparavant qui permettent le développement du territoire et sa capitalisation, ce qui porte à une durabilité du système et de la ressources génétique.

**Keywords:** *Genetic resources, Traditional systems, Valuation of livestock keepers culture, Designation of Origin.*

## Introducción

Existen dos planteos básicos sobre la estrategia de intervención para conservar y mantener los recursos genéticos en animales domésticos: el primero de ellos considera al animal *per se*, es decir la conservación de animales o grupos en estaciones experimentales, zoológicos o granjas educativas (Alderson, 1990), a la que en la actualidad se suma el concepto de conservación *in-vitro*, mediante conservación de semen u ovocitos congelados. Por el contrario otra corriente considera que la diversidad genética de las poblaciones de animales domésticos puede ser mantenida sólo en el contexto social y ambiental que les dio origen, fundamentándose en que la diversidad genética es principalmente el producto del proceso de selección dado por las condiciones ambientales locales combinadas con las estrategias de manejo y selección de las comunidades rurales que las crían (Köhler-Rollefson, 2000). Desde esta perspectiva la caracterización del recurso genético es el primer paso dentro de la estrategia de conservación (FAO, 1998). Los pasos posteriores deberían asegurar la sostenibilidad del recurso en el largo plazo.

En este sentido el trabajo realizado en relación con la Cabra Criolla Neuquina (CCN) adhiere al concepto de conservación enunciado por Köhler-Rollefson (2000), considerando la raza en el contexto del sistema rural tradicional del que es parte. A partir de 1997 el Instituto Nacional de Tecnología Agropecuaria (INTA) en cooperación con la Dirección de Agricultura y Ganadería (DAyG) de la provincia de Neuquén iniciaron una serie de trabajos de investigación tendentes a comprender el funcionamiento del sistema de

producción y caracterizar la población caprina de la región ubicada en el norte de la provincia de Neuquén, Patagonia, Argentina en un área de unos 30 000 km<sup>2</sup> (Figura 1). La utilización de enfoques sistémicos orientados a los actores (Long, 1992) y metodologías de investigación-acción (Albadalejo y Casabianca, 1997) que involucró a los destinatarios en los estudios, buscaba comprender sus prácticas así como el modelo de gestión de los recursos existentes.

Los resultados de estos trabajos de caracterización fenotípica, genética y productiva han establecido sus particularidades que en síntesis la muestran como una entidad genética única y definida (Lanari, 2004; Lanari *et al.*, 2006). La consideración de este enfoque sistémico, implicó involucrar los grupos sociales, en este caso de crianceros trashumantes, que son efectivamente quienes han modelado la población y viven de ella (Lanari *et al.*, 2005). El ambiente físico, la historia económica y social de la región así como la importante intervención de las políticas de



Figura 1. Provincia de Neuquén (Patagonia, Argentina) y zona de intervención.

desarrollo emanadas desde el estado provincial han influido sobre el sistema tradicional (Pérez Centeno, 2001).

Los crianceros, constituyen un grupo social de más de 1 500 familias con fuerte arraigo a la tierra. Sus unidades de producción, asentadas generalmente sobre tierras públicas, son destinadas esencialmente al autoconsumo, con una inserción limitada al mercado. La historia y evolución de la población rural de la región muestran la capacidad de transformación y adaptación de estrategias para sobrevivir en un ambiente físico y social difícil (Pérez Centeno, 2007).

El sistema rural tradicional se caracteriza por ser extensivo y trashumante, de estacionalidad estricta (Lanari *et al.*, 2006). El reconocimiento de acuerdos sociales internos y de las prácticas culturales de raigambre indígena lo muestran como una respuesta socialmente construida frente a la realidad en la que se ha desarrollado (Pérez Centeno, 2001). El sistema presenta actualmente restricciones tales como reducción de áreas de pastoreo de invierno (*invernadas*) y particularmente de verano (*veranadas*) y las correspondientes rutas de arreo, el envejecimiento de los productores asentados efectivamente en el campo y la migración de los jóvenes entre otros problemas, que son comunes a otras comunidades pastorales (Blench, 2000; Leneman y Reid, 2001). Estas se suman a las condiciones estructurales del sistema que presenta una alta dispersión geográfica, gran distancia a los mercados, estacionalidad marcada en la producción y bajo nivel de organización de la oferta. Sin embargo el principal producto del sistema, el "*chivito del norte neuquino*", no solo es motivo de orgullo para los crianceros sino que detenta un alto reconocimiento en los mercados regionales. La utilización de su nombre como argumento de venta por parte de los comercializadores, es un claro indicador del prestigio que goza el producto en sus mercados tradicionales. En la actualidad, no es posible la diferenciación del "*chivito*" por parte de los consumidores respecto a las producciones provenientes de otras regiones, ya que no existe ningún mecanismo que garantice su procedencia. La falta de diferenciación del producto en el mercado podría promover, como señala Akerlof (1970) una selección adversa ante la imposibilidad de reconocimiento de la calidad que castiga su precio de venta.

En otras palabras, nos situamos frente a un sistema marginal de baja dotación de recursos económicos y alta fragilidad de los recursos naturales pero que dispone de un alto capital

cultural, un recurso genético adaptado y un producto de calidad superior reconocida.

El trabajo interinstitucional contribuyó a la conformación de un espacio de diálogo entre crianceros, intermediarios, organizaciones profesionales, agentes de desarrollo e investigadores de diferentes disciplinas quienes construyeron una visión consensuada de la actividad, constituyéndose en una plataforma para el desarrollo territorial, basado en la valoración y la jerarquización de la producción caprina regional. El desafío que se planteó fue hacer sustentable al sistema, entendiendo que sólo de ese modo podrá dar lugar al desarrollo de esta comunidad rural y en consecuencia la preservación de su recurso genético.

El uso de signos de distinción de calidad como la Denominación de Origen (DO), surge como una herramienta que beneficia tanto al sector productivo como a los consumidores (Lacroix *et al.*, 2000) y de impacto social positivo (Jatib, 1995). Este signo no sólo distingue un producto sino que lo vincula con el saber hacer y la cultura existente detrás de la actividad productiva. Las experiencias existentes se localizan fundamentalmente en Europa mediterránea (Lambert-Derkimba, *et al.*, 2006), siendo los productos lácteos y los vinos los que más aprovechan estos mecanismos. En Argentina no se presentan ejemplos de DO en productos agroalimentarios a excepción de los vinos que son regulados según una legislación particular. En consecuencia la propuesta de valorizar un producto cárnico producido en un sistema tradicional en una región marginal de un país en desarrollo, supone atravesar nuevos caminos, crear condiciones y enfrentar un desafío.

En este trabajo se expone la experiencia realizada en el norte de la Patagonia Argentina, donde pequeños productores, intermediarios, comercializadores, e instituciones públicas se reunieron a fin de construir el marco tecnológico y organizativo de la Denominación de Origen (DO) para la carne caprina del norte neuquino. La hipótesis de nuestra experiencia sostiene que los mecanismos de diferenciación basados en el origen son una herramienta eficaz para la promoción del desarrollo territorial, la valoración de la cultura campesina y del recurso genético local.

## Materiales y Métodos

Las actividades desarrolladas se enmarcaron en un proyecto de Investigación y Desarrollo financiado por la Agencia Nacional de Ciencia y Técnica, el

Municipio de la ciudad de Chos Malal, principal centro urbano de la región y el INTA. El proyecto se inició en el año 2005.

Los dos aspectos básicos del trabajo fueron: la organización de los integrantes de la cadena de valor de la carne caprina regional para la construcción de la DO y la determinación de cualidades tecnológicas y nutricionales de los productos a proteger. Asimismo se realizaron estudios sobre la actividad comercial y la conceptualización que tienen los diferentes actores sobre la calidad.

La organización de los integrantes de la cadena de valor se consideró a través de talleres en diferentes parajes de la región norte de Neuquén. En ellos se procuró identificar las motivaciones para el inicio de un proceso de diferenciación, así como los niveles de articulación entre los actores. Los talleres efectuados tuvieron dos objetivos diferentes:

1. Talleres informativos y de sensibilización.
2. Talleres de Construcción de la DO (Figura 2).

### Talleres informativos y de sensibilización

Se efectuaron diez talleres en los cuales participaron más de trescientos productores, comercializadores e integrantes de quince instituciones de la región, a los que se informó sobre las diferentes alternativas para la diferenciación de productos agroalimentarios (Marcas comerciales, DO, IG, Producto Orgánico), las especificidades de los mismos y las exigencias para su obtención. Esta actividad de sensibilización fue acompañada por una campaña informativa a través de diferentes medios locales (radial, gráfico y televisivo) focalizada en los establecimientos educacionales con el fin de sensibilizar sobre el valor del recurso productivo y la necesidad de su protección en el mercado.

### Talleres de Construcción de la DO

En una segunda etapa a lo largo de cuatro talleres, se indagó sobre la representación que la sociedad tiene del Norte Neuquino, sobre las especificidades de su identidad, los modos de producción local, así como los límites socialmente reconocidos de dicho territorio.

Los mencionados Talleres fueron la base de las actividades posteriores que incluyeron: Talleres de discusión sobre formas de asociación, constitución

del consejo regulador de la DO, reglamentaciones y aspectos legales.

Los aspectos tecnológicos incluyeron la determinación de indicadores de calidad para las distintas fases de la elaboración del producto, es decir:

- La caracterización de las categorías a proteger, el grado de terminación in vivo.
- La calidad de la canal y la calidad sensorial.

Este trabajo se realizó en el Frigorífico de Chos Malal, cuyas instalaciones y procedimientos habilitan para la comercialización de los productos cárnicos a destinos diversos. Todos los muestreos realizados fueron realizados en época normal de comercialización, que corresponde a los meses de octubre a abril.

Por último se realizó un análisis de la demanda en el ámbito de operadores comerciales mediante encuestas a intermediarios, comercializadores y restaurantes, localizados en el área de producción así como en los centros naturales de consumo: la región de los Lagos cordilleranos, área de actividad turística, y en el Alto Valle de Río Negro y Neuquén, que con cerca de medio millón de habitantes es el



Figura 2. Foto tomada durante uno de los talleres informativos.



Figura 3. Foto del grupo delimitando la región.

mayor conglomerado urbano de la Patagonia. El objetivo particular de este análisis fue comprender los modos de compra y venta a lo largo de la cadena productivo-comercial, desde el criancero hasta el consumidor, así como la forma en que se construye la calidad del producto.

## Resultados

La realización de los talleres informativos permitió consensuar el concepto de distinción de calidad como herramienta para poner en valor la producción caprina. Se observó un marcado orgullo por el ser "criancero" y por el producto "chivito", destacándose el valor que le asignan a la raza Criolla Neuquina. Esta autovaloración resulta fundamental al momento de construir la DO.

En los Talleres de construcción de la DO, la participación de más de cien productores, comercializadores e instituciones permitió explicitar la imagen común, que resume la especificidad regional. Los siguientes elementos surgieron como los de mayor importancia:

- La presencia de la Cabra Criolla Neuquina en cualquiera de sus dos biotipos.
- La realización de la trashumancia.
- La homogeneidad de los pastizales de los campos de veranada ubicados en la alta cuenca del río Neuquén y Barrancas.

Estos elementos delimitan territorios diferentes que se superponen en el área que define la Denominación de Origen (Figura 3). En ella se

evidencia una identidad común construida en función del uso del espacio y los modos de circulación. El área de la DO está integrada por todas las unidades de producción que hacen trashumancia en los campos de veranada ubicados en los departamentos Minas, Chos Malal, Pehuenches o Ñorquin (Figura 4).

Los modos de producción que caracterizan a la región fueron descritos en dos talleres, en los cuales detallaron la gestión del rodeo, el manejo reproductivo, nutricional, sanitario, así como la rotación entre los diferentes campos y el arreo. El ciclo anual de producción fue definido como estrictamente estacional, con servicio de

otoño y parición de primavera, gracias al trabajo del *castronero* o *chivatero*<sup>1</sup>, en lugares alejados fuera de la época de servicio. Esta práctica fue desarrollada sin intervención externa surgida frente a la necesidad de regular la época de los nacimientos. La existencia de pautas no escritas, como los modos de retribución, los momentos de recepción y entrega de los reproductores y las formas de sancionar los descuidos en el manejo, permiten reconocerla como una práctica institucionalizada, que si bien se encuentra en sistemas productivos vecinos, no manifiesta igual intensidad.

La trashumancia entendida como "... el hecho de trasladarse de un lugar a otro por arreo o excepcionalmente en camión. No importa el medio...el tema es estar un tiempo en una parte y otro tiempo en otra parte. Esto es lo que nos caracteriza a nosotros;... es un elemento estructurador de las relaciones sociales, ya que la participación de la familia permitió la formación de vínculos con pobladores distribuidos a lo largo de la ruta de arreo. Esto se constituyó en un elemento homogeneizador de las relaciones sociales y la información entre los productores. La alternancia entre los campos bajos y los campos altos fue señalada como un elemento esencial para la tipicidad del producto: El cambio de pastura es lo que da el sabor al chivo. Si no se cambia de pasto, no hay sabor del chivo...".

Al definir qué tipo de animal y qué producto se debería proteger con la DO, se definió claramente por proteger la raza Criolla Neuquina y al chivito

<sup>1</sup>Castronero o chivatero: Productor especializado en el cuidado de machos normalmente durante el período noviembre a marzo.



Figura 4. Mapa del área de la DO

con dos categorías posibles; el “chivito mamón”, de hasta 90 días de edad, lactante y que no hubiese realizado arreas a las pasturas altas, y el “chivito de veranada”, que realiza al menos un arreo y se ha alimentado de las pasturas de las veranadas, siendo su edad límite los 180 días. El nombre elegido por los propios participantes fue “Chivito Criollo del Norte Neuquino” (Figura 5)

El trabajo sobre los aspectos tecnológicos estuvo dirigido a establecer los parámetros y los indicadores de cada una de las categorías que los mismos crianceros buscan proteger en la DO. Los resultados de estos estudios fueron detallados por Domingo *et al.* (2005). En base a estos resultados se estableció una metodología para la clasificación de las canales y los umbrales de calidad pertinentes a la distinción con el sello de la DO, además del desarrollo de indicadores de calidad *in vivo*.

Como resultado del trabajo de talleres y sobre los aspectos que hacen a la calidad del producto, se redactó y acordó con los interesados el Protocolo de la DO. Este documento fue presentado ante las autoridades de la Secretaría de Agricultura, Ganadería, Pesca y Alimentación en diciembre de 2005 por el Consejo de Promoción de la Denominación. Dicha presentación fue la primera solicitud formal en Argentina en el marco de la ley N° 25.380. Simultáneamente se constituyó el *Consejo Regulador* conformado por representantes de la cadena de valor (productores, comercializadores y transformadores) y el *Consejo Asesor* integrado por las instituciones tecnológicas, académicas y de desarrollo vinculadas al sector. Esta iniciativa permitió la organización del sector y la articulación entre los actores alrededor de un proyecto común.

Al mismo tiempo, se estudió el mercado local y regional (Alto Valle del Río Negro y Lagos cordilleranos) así como las articulaciones entre los diferentes actores de la cadena (productores, matarifes, restaurantes, supermercados y consumidores) con respecto a la calidad del producto. Simultáneamente, se evaluaron diferentes alternativas de presentación de productos (desarrollo de cortes comerciales, envasado al vacío, etc.), así como nuevas vías de comercialización para productos Premium.

## Discusión

La presente experiencia nos ha permitido la implementación de nuevos enfoques aplicados a la investigación y el desarrollo dirigido a espacios multiactorales con énfasis en el sector campesino. Un enfoque orientado a los actores y su reconocimiento como sujetos “*capaces*” y “*competentes*” para delinear su propio desarrollo resulta esencial como punto de partida de la intervención pública.

Por otra parte este reconocimiento aplicado a la gestión de los recursos genéticos, conduce a reafirmar el derecho de los crianceros sobre el recurso. En este proceso iniciado en 1997 se ha demostrado no sólo que los crianceros han sido los formadores de la raza Criolla Neuquina (Lanari *et al.*, 2005), que han construido y adaptado con sus propios conocimientos y sus propias estrategias de sobrevivencia en el marco de su sistema rural (Pérez Centeno, 2007), sino que también son activos en la



Figura 5. Logo de presentación del producto protegido por la Denominación de Origen.



formulación de propuestas superadoras. En este sentido este trabajo coincide con el concepto promovido por Lohkit Pashu-Palak Sansthan (2005) según el cual son los propios campesinos los que pueden y deben tomar sus propias decisiones con relación a sus recursos genéticos. Estos derechos los resguardan de perder la propiedad sobre los mismos, al tiempo que previene la introducción inadecuada de germoplasma exótico, frecuentemente promovida por intereses externos a las comunidades.

La valorización de los recursos genéticos y los saberes locales como capital permitió la construcción de un desarrollo alternativo que parte ya no de la asimilación de modelos exógenos basados en producciones estándares sino desde su identidad cultural.

La metodología de investigación-acción que ha promovido la concertación de los objetivos de investigación y la participación activa de los destinatarios durante la implementación de las mismas ha posibilitado la estructuración de un espacio de confianza fructífero que facilitó el intercambio de saberes, la comprensión de sus prácticas y la apropiación de las acciones públicas por parte de los beneficiarios.

La protección de un producto ligado a un recurso genético específico puede estar fundada en su tipicidad o simplemente estar relacionado al marketing (Lambert-Derkimba, *et al.*, 2006). En nuestro caso, el recurso genético se halla ligado al sistema y su gente de modo estrecho y por lo tanto su vínculo es genuino.

Desde el punto de vista tecnológico esta experiencia ha sido innovadora en la puesta en valor de un producto local, al que se le aplican criterios de calidad y seguridad que protegen al consumidor y le dan garantías sanitarias y nutricionales. Por otra parte los aspectos productivos, se ponen del mismo modo en la perspectiva de la calidad y la sostenibilidad ambiental, orientando de este modo las decisiones productivas.

La articulación con otras actividades sociales y productivas movilizadas a partir de la valoración de la identidad local y la cultura, implícitas en la Denominación de Origen, genera una sinergia en las actividades desarrolladas en la región que refuerzan las interacciones entre los espacios rurales y los urbanos.

Por otra parte la DO ha favorecido el desarrollo de la institucionalidad, como es el Consejo de

Regulador y las Asociaciones profesionales que refuerzan a través de dicho espacio su identidad. El fortalecimiento de las organizaciones campesinas y la conformación de un espacio multiactoral vinculado al sistema productivo permite niveles de concertación y articulación inexistentes hasta el presente que potencian el desarrollo del territorio y lo capitalizan. La DO abre las puertas a la revalorización territorial dando un nuevo horizonte a la sostenibilidad del sistema.

## Referencias

- Akerlof, A.** 1970. The market for lemons: quality uncertainly and the market mechanism. *Quarterly Journal of Economics*, (84). 488-500.
- Albadalejo, C. & F. Casabianca.** 1997. *Eléments pour un débat autour des pratiques de recherche-action. Etudes et Recherches sur les Systèmes Agraires et le Développement*, INRA, pp. 127-149.
- Alderson, L.** 1990. The work of the rare Breeds Survival Trust. In: L. Alderson (Ed.) "Genetic Conservation of Domestic Livestock". CAB Internac. London. Cap. 3: 33-43.
- Blench, R.** 2000. Extensive Pastoral Production Systems: Issues and Options for the future. FAO, pp. 78.
- Domingo, E. M. Zimerman, R. Raiman & M.R. Lanari.** 2005. Caracterización de las canales de Chivitos Criollos Neuquinos. *Revista Argentina de Producción Animal*. 25:(Suplemento 1) pp. 370.
- FAO.** 1998. Primer documento de líneas directrices para la elaboración de planes nacionales de gestión de los recursos genéticos de animales de granja, pp. 146.
- Jatib, M.I.** 1995. Propuestas para la implementación del sistema de denominaciones de origen en argentina. In: Primer seminario internacional de denominaciones de origen. SAGPyA. Buenos Aires, 19-20 de abril, pp. 179-204.
- Köhler-Rollefson, I.** 2000. Management of animal genetic diversity at community level. I. Köhler-Rollefson (Ed.), GTZ, GMBH, pp. 24.
- Lacroix, A., A. Mollard & B. Pecquer.** 2000. Origine et produits de qualité territoriale: du signal à l'attribut? 01-21. (Abstract).

**Lambert-Derkimba, A., F. Casablanca & E. Verrier.** 2006. L'inscription du type génétique dans le reglements techniques des produits animaux sous AOC: conséquences pour les races animales. INRA Prod. Anim. 19: 357-370.

**Lanari, M.R.** 2004. Variación y diferenciación genética y fenotípica de la Cabra Criolla Neuquina en relación con su sistema rural campesino. Fac. Biología. Centro Regional Universitario Bariloche. Univ. Nacional del Comahue, pp. 234.

**Lanari, M.R., E. Domingo, M. Pérez Centeno & L. Gallo.** 2005. Pastoral community selection and genetic structure of a local goat breed in Patagonia. FAO, AGRI 37: 31-42.

**Lanari, M.R., M. Pérez Centeno, & E. Domingo.** 2006. La Cabra Criolla Neuquina y su sistema de producción. En: FAO (2006) People and animals. Traditional Livestock keepers: guardians of domestic animal diversity. A documentation of 13 case studies on how communities manage their local animal genetic resources. K. Tempelman and R.A. Cardellino (Eds). FAO Interdepartmental Working Group on Biol. Divers. For Food and Agric. Rome, Italy.

**Leneman, M. & R. Reid.** 2001. Pastoralism beyond the past. Development, Local/Global Encounters 44 (4): 85-89.

**Lokhit Pashu-Palak Sansthan.** 2005. Indigenous breeds. Local communities. Documenting Animal Breeds and Breeding from a Community Perspective. Ed. I. Köhler-Rollefson. Mudra, India, pp. 64.

**Long, N.** 1992. Battlefields of knowledge. The Interlocking of Theory and Practice in Social Research and Development. Routledge. London & New Cork, pp. 306.

**Pérez Centeno, M.** 2001. Etude des stratégies de la petite production familiale minifundiste et de son articulation avec les institutions du développement. Le cas des éleveurs transhumants du Nord de la Province de Neuquén (Patagonie Argentine). Université de Toulouse Le Mirail, pp.123.

**Pérez Centeno, M.** 2007. Transformations des stratégies social et productives des Crianceros transhumants de la province de Neuquén et leurs relations avec les interventions de développement. Thèse de doctorat (In Press).

## Experience in establishing a herd book for the local Nguni breed in South Africa

M.M. Scholtz<sup>1,2</sup> & K.A. Ramsay<sup>3</sup>

<sup>1</sup>Post Graduate School in Animal Breeding, University of the Free State, P.O. Box 339, Bloemfontein 9301, South Africa

<sup>2</sup>(Corresponding address: ARC – Animal Production Institute, Private Bag X2, Irene 0062, South Africa)

<sup>3</sup>Department of Agriculture, Private Bag X138, Pretoria 0001, South Africa

### Summary

For many years the performance of the indigenous livestock of Africa was regarded as inferior. It was only when the results of research and performance recording were published that the value of a breed such as the Nguni was acknowledged. This resulted in an interest in the breed from commercial farmers, which led to the establishment of a breeder's society in 1986, but with no official pedigrees it was a challenge to establish a herd book.

This article describes how the principles of upgrading were initially used to develop a herd book until the Nguni was recognized as an established breed in 1996. Subsequently a system of first registration was implemented. This system caters for emerging black farmers in South Africa who want to become seed stock breeders and allows for the good quality Nguni genetic material available to the communal black farmers to enter the seed stock industry.

### Résumé

La performance des animaux indigènes Africains a été pendant longtemps considérée comme médiocre. C'est seulement après la publication des recherches et résultats de leurs performances que la valeur des races comme la Nguni a été reconnue; d'où l'intérêt soudain des fermiers pour cette race; intérêt qui résultera en la formation d'une Association d'éleveurs de la race Nguni en 1984; toutefois en l'absence des données fiables concernant leur pedigree, il était difficile d'établir le "herd book" de ces animaux.

Cet article décrit comment les méthodes d'amélioration génétiques avaient été entreprises pour l'établissement d'un "herd book" qui conduisit

à la reconnaissance de la Nguni en tant que race en 1996; ce qui d'office résultait en la mise sur pieds d'un système d'inscription qui, d'une part pourvoit une place pour les fermiers noirs Sud-africains désireux de devenir éleveurs d'animaux de type pur sang Nguni; de l'autre ce système prévoit qu'une semence Nguni de bonne qualité soit disponible parmi les fermiers noirs; ce qui leur faciliterait l'accès au sein de l'Association d'éleveurs de la race Nguni.

### Resumen

Durante mucho tiempo se ha considerado el rendimiento de las razas indígenas africanas como mediocre. A raíz de la publicación de una serie de resultados e investigaciones sobre sus rendimientos el valor de algunas razas como la Nguni ha sido reconocido; de ahí el interés de algunos ganaderos por esta raza. Este interés llevó en 1984 a la creación de una asociación de ganaderos de la raza Nguni. Sin embargo, dada la escasez de datos fidedignos sobre el pedigrí era difícil establecer un libro genealógico de estos animales. Este artículo describe cómo se llevaron a cabo los métodos de mejora genética para establecer un libro genealógico que llevó al reconocimiento de la Nguni como raza en 1996. Esto fue posible gracias a la puesta en práctica de un sistema de inscripción que, por una parte, da espacio a los ganaderos negros sud-africanos que desean criar animales de tipo pura sangre Nguni, por otro lado, este sistema prevé que el semen de buena calidad de Nguni sea disponible para los ganaderos negros, lo que le facilitará el acceso a la asociación de ganaderos de raza Nguni.

**Keywords:** Sanga cattle, Commercial breeders, Upgrading program.

## Introduction

The Sanga cattle (*Bos Taurus africanis*) (Meyer, 1984) originally found along the east coast of Southern Africa are known as the Nguni. Due to a lack of performance recording during the period of colonization, these cattle and many other indigenous livestock of Africa were regarded as inferior. This perception was the result of African man living in a symbiotic relationship with his animals. His animals were invaluable as they provided for most of his needs (Matjuda, 2005). In addition, the status value of animals resulted in more animals being kept and overstocking became the order of the day (Scholtz, 1988). A second reason for the earlier ignorance surrounding the qualities of the Nguni stemmed from the variety of colours and colour patterns often encountered amongst animals of the breed. These wide ranges of colours and colour patterns are in sharp contrast to the general tendency in the stud breeding industry to emphasize uniformity. As a result of this, the stud breeding industry was unable to identify the much emphasized antiquated breed standards (Bonsma, 1980), and regarded these animals as an indiscriminate mixture of breeds (Scholtz, 1988).

In South Africa, this perception of inferiority led to the promulgation of an Act in 1934 in which indigenous breeds and types were regarded as 'scrub' (non descript). Inspectors were appointed to inspect the bulls in communal areas (those in possession of indigenous Africans) and to castrate them if regarded as inferior. Fortunately this Act was applied effectively for only a few years, since it was very unpopular (Hofmeyr, 1994). During the first part of the previous century little or no attention was paid to the improvement or study of the potential of indigenous cattle breeds in South Africa, except for the Afrikaner.

The potential of the Nguni was only demonstrated following the introduction of a beef cattle recording scheme in 1959 in South Africa and the publication of research results on the Nguni in the early 1980's. This resulted in a keen interest in the Nguni by the commercial farmers of South Africa, and the Nguni has now grown numerically to be the second largest stud beef breed in South Africa, according to the information obtained from South Africa's national database (Integrated Registration and Genetic Information System-INTERGIS) on 1 April 2007.

All the seed stock (stud) of Ngunis originates from the original custodians (communal farmers) that maintained the breed over many centuries. However, there was no benefit sharing by these

original custodians and in many cases they were exploited by the commercial farmers in order to take possession of their animals. Currently there is still very good quality Nguni genetic material available to South Africa's communal black farmers. Recognizing the value of such genetic material, the Nguni Cattle Breeder's Society in collaboration with the Agricultural Research Council (ARC) developed a process of first registration to cater for such animals. This system specifically caters for emerging black farmers that want to become Nguni stud breeders.

## Methods

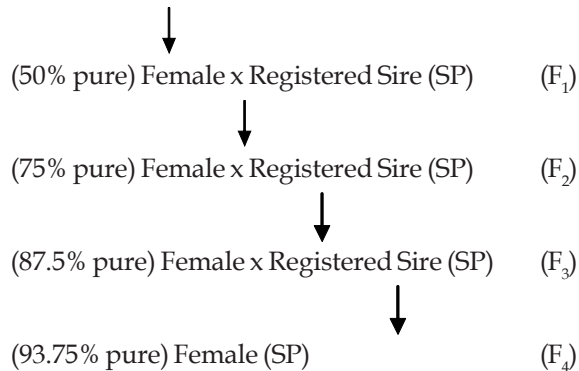
The interest in the Nguni from commercial breeders had already begun in the 1970's, when the only source of Ngunis was in remote tribal areas where the influence of imported exotic breeds was less prevalent (Hobbs, 2006). The initial attempts to collect animals from these areas were difficult. The commercial breeders were lucky to find animals that could be bought as "*nothing was for sale*" and such attempts would on many occasions result in the collection of only one heifer and an old cow or two with only one teat that had survived the onslaught of ticks.

In the 1980's the interest in the Nguni from the commercial sector accelerated and in August 1983 the breed was recognized as a developing breed under the Livestock Improvement Act (No. 25 of 1977) and a breeder's society was established in 1986. At that stage there were about 3 000 Nguni females in a few well managed herds (mostly government farms). However, the Nguni in the communal areas was under severe threat, mainly due to crossbreeding with the Brahman (Scholtz, 2005). During this period there were no effective mechanisms in place to control the acquisition of Ngunis, and the original custodians in many cases were exploited by commercial farmers in order to take possession of their animals; *inter alia* two Brahman heifers would be swapped for one Nguni heifer.

With a breeder's society in place, but with no pedigree information, it was a challenge to establish a herd book. The usual techniques, namely top crossing or upgrading (Dalton, 1980) were not applicable to the Nguni. A top cross is when a breeder or breeders go back to the original source of the breed for some new genetic material. In the case of the Nguni this could not be done, since there was no herd book.

*Upgrading* is where one breed is changed (graded up) to another by continued crossing. It has been widely used throughout the world where stock was graded up by a number of crosses with registered Studbook Proper (SP) sires from a specific breed. It is commonly accepted that four generations of crossing with a registered sire (SP) will result in purebred status.

An upgrading program will work as follows:  
Unspecified original Female x Registered Sire (SP)



These principles of upgrading were adapted in the initial development of a herd book for the Nguni. In contrast to normal upgrading where the  $F_1$  is 50% pure, in this case  $F_1$  referred to animals that were phenotypically Nguni, but with no pedigree information. In cases where the farmers had pedigree information, their animals were accepted as  $F_2$ , irrespective of the number of pedigree generations.

The development process was thus as follows:

$$F_1 \times F_1, F_2, F_3 \text{ or } F_4 = F_2$$

$$F_2 \times F_2, F_3 \text{ or } F_4 = F_3$$

$$F_3 \times F_3 \text{ or } F_4 = F_4$$

$$F_4 \times F_4 = F_4$$

$F_1$  referred to animals that were phenotypically Nguni, but with no pedigree information. In cases where the farmers had pedigree information, their animals were accepted as  $F_2$ , irrespective of the number of pedigree generations.

In 1996 the Nguni was recognized as an established (developed) breed, and the system changed from the F rating to an appendix and SP (Studbook Proper) system. All  $F_1$  and  $F_2$  animals that met the breed standards were classified as

Appendix A,  $F_3$  animals as Appendix B and  $F_4$  animals as SP.

This system worked as follows:

$$\text{Appendix A} \times \text{A, B or SP} = \text{Appendix B}$$

$$\text{Appendix B} \times \text{B or SP} = \text{Studbook Proper}$$

## Results and Discussion

The interest from the seed stock industry in the Nguni resulted in revived interest in the Nguni from the emerging/small scale sector. It is now generally accepted that the research and performance results that were published saved the Nguni from the possible threat of extinction. The Nguni has now grown numerically to the second largest stud beef breed in South Africa. The stud animals currently consist of over 30 000 females with an estimated 1.8 million Nguni type animals in South Africa. This clearly demonstrates the important role a breeder's society can play in *in-situ* conservation.

Currently there is still very high quality Nguni genetic material available amongst the cattle of South Africa's communal black farmers. However, up to now there has not been an easy way that this genetic material could enter the seed stock industry. Recognizing the value of such genetic material, the Nguni Cattle Breeder's Society in collaboration with the ARC developed a process of First Registration to cater for such animals. First Registration (FR) refers to phenotypically Nguni animals that enter the Nguni register from the first time, e.g. a farmer who has been farming commercially with Ngunis and now wants to become a Stud Breeder. This system also specifically caters for emerging black farmers who want to become Nguni Stud Breeders, and they are encouraged to enter the Seed Stock Industry.

This system works as follows :

First Registration (FR) x FR, A, B or SP = Appendix A (Phenotypic Nguni)

$$\text{Appendix A} \times \text{A, B or SP} = \text{Appendix B}$$

$$\text{Appendix B} \times \text{B or SP} = \text{Studbook Proper}$$

Restriction is placed on the sale of FR animals firstly to ensure that not only do they look like pure Ngunis, but also that they breed and perform like pure Ngunis and meet the minimum breed standards. Secondly the restriction ensures that the FR animals remain in the ownership of emerging

farmers for a period of time, and are not exploited by established seed stock breeders who want to take possession of their good quality animals.

In the case of females a cow must have at least one calving interval and her average calving interval must not exceed 550 days. At least one of her calves must also have passed an inspection before she can be sold. Bulls must have at least 20 progeny submitted for inspection of which 50% have passed the inspection, before it can be sold.

The ARC launched an alien plant control programme in communal areas north of Pongola in KwaZulu-Natal. Following this project one of the communities demonstrated their intentions to commercialize their livestock enterprise. The Emoyeni community of 18 families secured the grazing rights to approximately 1 500 hectare of communal land. They have 85 sexual mature females most of which are Ngunis of high genetic quality that can enter the system of First Registration of the Nguni Cattle Breeders Society, and the ARC is busy assisting them with this process.

## Conclusion

If the intervention in the Emoyeni community is successful it will be the first instance in South Africa and probably the world, where a communal community progressed to be stud farmers using their own original animals. For the first time it will be possible for communal farmers to benefit from the exceptionally high prices that are currently being paid for Stud Nguni cattle in South Africa.

A Breeder's Society can play a pivotal role in the sustainable use of local livestock genetic resources, since it can act as the modern custodians for the sustainable utilization of such breeds. However, they should move away from the antiquated overemphasis on uniformity and artificial breed

standards, while ensuring that such breeds remain or become competitive. This will necessitate proper pedigree and performance recording in order to identify any undesirable genetic drift and to ensure competitiveness through proper breeding programs designed for local conditions.

## List of References

- Dalton, D.C.** 1980. An introduction to practical animal breeding. Granada Publishing, Great Britain.
- Bonsma, J.C.** 1980. Livestock Production - A global approach. Tafelberg, Cape Town.
- Hobbs, P.** 2006. Musings of a (white) Nguni veteran. Nguni Journal, 3-9.
- Hofmeyr, J.H.** 1994. Findings of a committee re a gene bank for Livestock. Proc. Conf. Conservation Early Domesticated Animals of Southern Africa, Pretoria, 3-4 March 1994.
- Matjuda, L.E.** 2005. The role of the Angus breed in the emerging beef sector in South Africa. Proc. 9<sup>th</sup> World Angus Forum Technical Meeting. Cape Town, 19 March 2005, 61-65.
- Meyer, E.H.H.** 1984. Chromosomal and biochemical genetic markers of cattle breeds in southern Africa. Proceedings of the 2<sup>nd</sup> World Congress on Sheep and beef Cattle Breeding, 328-339.
- Scholtz, M.M.** 1988. Selection possibilities of hardy beef breeds in Africa: The Nguni example. Proc. 3<sup>rd</sup> World Congr. Sheep Beef Cattle Breed. Paris, 19-23 June 1988, 303-319.
- Scholtz, M.M.** 2005. History and background of the Nguni in South Africa. Nguni Journal, 7-9.

# Development of international genetic evaluations of dairy cattle for sustainable breeding programs

W.F. Fikse & J. Philipsson

*Interbull Centre, Dept. of Animal Breeding and Genetics,  
Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden*

## Summary

A large proportion of dairy foods consumed by humans are produced using milk from commercial dairy breeds. The result of high selection intensities, narrow breeding objectives and ignoring inbreeding in past decades is that much attention now needs to be given to conserving these commercial breeds to maintain and increase food production and meet future demands. The characteristics of a sustainable breeding program are broad breeding objectives, measures to control inbreeding rates and continuous genetic improvement to keep populations competitive. It is necessary to include traits in the breeding objectives that reduce the cost price of products in addition to traits that increase the output of products. Breeding objectives differ between countries (production environments), and together with genotype-environment interaction for single traits (e.g. milk yield) the implication is that ranking of animals for local breeding goals differs between countries (production environments). Acknowledging this in selection programs leads to larger number of selected animals - at least on a global level, adding to the global diversity in commercial dairy cattle populations. Interbull provides international comparisons of bulls from six dairy breeds for most of the economically important traits, thereby enabling global selection for broad breeding objectives in many countries around the world.

## Résumé

Une grande partie des produits laitiers pour la consommation humaine provient de lait de races commerciales. Le résultat d'une sélection intense, d'objectifs d'amélioration limités et ne pas tenir compte des problèmes de consanguinité dans le passé nous portent aujourd'hui à la nécessité d'une

majeure attention à la conservation de ces races commerciales tout en conservant et augmentant la production alimentaire pour faire face à la demande dans le futur. Les caractéristiques d'un programme d'amélioration durable sont les objectifs plus larges, les mesures pour contrôler les niveaux de consanguinité et l'amélioration génétique continue pour obtenir que les populations soient compétitives. Il est nécessaire d'inclure certains traits dans les objectifs d'amélioration qui aident à réduire le coût des produits, ainsi que d'autres qui permettent d'augmenter la production de ces mêmes produits. Les objectifs d'amélioration dépendent des pays (p.e. milieu de production) et de l'interaction génotype-milieu pour chacune de ces races (p.e. performances lait), ce qui entraîne que la marge du nombre d'animaux disponible pour les objectifs d'amélioration soit différente d'un pays à l'autre (milieu de production). Prenant en considération ce point nous pouvons augmenter le nombre d'animaux sélectionnés, au moins au niveau mondial, ainsi que la diversité mondiale dans les populations de bovin à lait. Interbull fournis des comparaisons au niveau internationale de taureaux appartenant à six races laitières parmi les plus rentables et importantes du point de vue commercial, ce qui permet une sélection mondiale pour des plus amples objectifs d'amélioration dans beaucoup de pays dans le monde.

## Resumen

Una amplia parte de los productos lácteos para consumo humano provienen de leche de razas comerciales. El resultado de una selección intensificada, objetivos de mejora limitados y no tener en cuenta los problemas de consanguinidad en las pasadas décadas hacen que ahora sea necesaria una mayor atención para conservar estas razas comerciales al mismo tiempo que se mantiene e incrementa la producción alimentaria para hacer

frente a la demanda futura. Las características de un programa de mejora sostenible son los amplios objetivos de mejora, las medidas para controlar los niveles de consanguinidad y una mejora genética continua para conseguir que las poblaciones sean competitivas. Es necesario incluir algunos rasgos en los objetivos de mejora que reduzcan el costo de los productos, así como otros que incrementen la producción de los mismos. Los objetivos de mejora dependen de los países (p.e. ambiente de producción), y junto con la interacción genotipo-ambiente para cada una de las razas (p.e. rendimiento en leche), hacen que el margen de animales para los objetivos de mejora local difieren de un país a otro (ambientes de producción). El reconocer esto en un programa de selección permite ampliar el número de animales seleccionados, por lo menos a nivel mundial, ampliando la diversidad mundial en las poblaciones de vacuno de leche. Interbull proporciona comparaciones internacionales de toros pertenecientes a seis razas lecheras provenientes de entre las más económicamente importantes, lo que permite una selección mundial para mayores objetivos de mejora en muchos países del mundo.

**Keywords:** *Sustainability, Breeding objectives, Inbreeding, International genetic evaluations.*

## Introduction

Globally, milk is one of the most important source of nutrients for human consumption. The so-called livestock revolution, envisaged by Delgado *et al.* (1999), predicts that the global demand for milk will increase considerably over a 20-year period. Developing countries will more than double their production (133%), whereas the developed world needs to increase production by just 7% to meet future demands. Most milk is produced by cattle, although buffalo, sheep and goats play very important roles for milk production in certain countries. Future demands for milk cannot be met by an increased number of animals but must result from increased productivity per animal and efficiency in the use of feed resources considering availing environments and production systems. The increased global demand for dairy products points to the importance of the commercial dairy breeds, and the need to ensure that breeding programs for these breeds are sustainable.

So far much of the national and international conservation efforts have been directed towards already endangered or nearly extinct breeds, whereas little emphasis has been put on the 'mainstream breeds' as their numbers are still quite high. In a developed country like Sweden, for example, only about 0.5% of the dairy herd population consists of endangered breeds and they produce about 0.3% of the milk.

If breeding programs for the major dairy breeds of the world fail to be sustainable the effects may be dramatic in several ways: demands for food will not be met, major losses in animal genetic diversity will occur and severe effects on land use and crop diversity may follow. Modern reproduction technologies, such as artificial insemination (AI) and embryo transfer (ET), have been proven to be very powerful tools in changing the genetics of cattle populations. The dynamics of these commercial populations effectively using AI and ET are therefore more important to monitor than just actual numbers of animals at a given time. The issue of genetic diversity is related to the number of breeds with distinctly different characteristics, the effective population size of each of these breeds, and effects of the within breed selection programs practiced.

The objectives of this paper are to illustrate the globalization of six major breeds or groups of breeds used for dairy production as a result of extensive use of AI and ET, some circumstances threatening the sustainability of the breeding programs practiced, and measures taken to improve the use of these genetic resources in such a way that demands for genetic diversity and sustainability can be met along with continuously improved production. Opportunities to monitor important genetic changes in the world's major dairy production breeds have been made possible since the establishment of Interbull, initially founded by European Association of Animal Production (EAAP), International Dairy Federation (IDF) and the International Committee of Animal Recording (ICAR). Nowadays regular exchange of data takes place between Interbull and nearly 30 countries in order to conduct international genetic evaluation of bulls. Nearly all continents are represented among these developed countries with two from North America, two from Oceania, one from Africa, one from Asia and the remainder from Europe.



## Globalization of Breeds Included in Interbull Evaluations

An enormous increase in the semen trade followed the disclosure of results from the extensive FAO-experiment conducted in Poland, where 10 Friesian strains of dairy cattle were compared (Stolzmann *et al.*, 1981). The results showed an unexpectedly significant superiority of North-American Holstein-Friesians (HF) in production over their European ancestral populations. The New Zealand and Israeli populations also surprised many with their high productivity. A wave of importation of HF semen followed, and in a decade or two the black and white dairy cattle populations around the world had been 'Holsteinized' and the effective population size declined dramatically. Figure 1 shows that the Friesian cattle in northern Europe also went through a dramatic morphological change.

A parallel development also took place in other breeds. Braunvieh cattle had, similarly to Friesian cattle, been exported from western Europe to North America, where a new type of Brown Swiss was developed. Although this population was small it has provided the European ancestral populations with a lot of semen in the last 3-4 decades. The Red breed group, with Ayrshire ancestry, of Finland (Finnish Ayrshire), Norway (Norwegian Red) and Sweden (Swedish Red) started an early exchange of bull sire semen and became genetically closely linked. Ayrshire cattle, although only in small populations, were also part of the dairy populations in other regions of the world, e.g. North America, South Africa, Australia and in its area of origin in the UK. The Jersey breed had at an early stage

become a globally utilised breed, well adapted to many different environmental conditions, including tropical areas. Genetically it differs markedly from most other commercial dairy breeds in live weight and milk composition. The Jersey breed has been very competitive in many countries, especially in Denmark, the USA and New Zealand, where the biggest populations are found. The other Channel Island breed, the Guernsey, has also been used globally, but in a limited number of primarily Commonwealth countries. Major populations are found in the USA, the UK and Australia, but the number of cows has been rapidly decreasing in the last decades, despite its many interesting features. Another breed which has been spread to many countries is the Fleckvieh, primarily from central Europe, and internationally named as the Simmental. It is a dual purpose breed, but has been diverted into different lines for milk and beef vs. only for beef in some countries. The population used for dairy production is seen only in Europe and has largely been developed by use of Red Holstein semen imported from North America.

### Need for comparable information

These breed and industry developments emphasized the need for methods to compare the genetic merit of bulls across countries in order to improve efficiency in the global selection of bulls. This challenge was taken up by both the IDF and EAAP, which in 1983 led to the formation of Interbull as an international committee for improved transparency of genetic evaluations of dairy cattle around the world. Following this development the Interbull Centre was established in 1991 aiming at conducting international genetic



Figure 1. European Friesian before (a)..... and after 'Holsteinization' (b).

evaluations of bulls including the breeds mentioned above (Philipsson, 1998).

## Exchange of Genetic Material

The magnitude of exchange of genetic material can be illustrated in many ways. For example, the USA exported nine million semen doses (dairy bulls) in 2005, an increase of nearly 20% in 10 years. European AI organizations exported approximately five million semen doses in 2004. Through the Interbull system pedigree data on AI bulls is collected from 26 different countries on a routine basis, which makes it possible to monitor developments for the various breeds at the global level. The exchange of genetic material will be illustrated below based on information in the Interbull pedigree database.

Young bulls are typically tested in the country of birth and first registration (Table 1). The Guernseys and Holsteins showed the most exchange at the level of young bulls among the breed groups and countries considered in the Interbull evaluations; approximately 15% of the progeny tested bulls did

not originate from the country in which they were tested. The trend for Guernsey, Holstein and Jersey is to import more young bulls from other countries, whereas the converse is true for the Brown Swiss and Red Dairy cattle breed groups.

The exchange of genetic material between countries is much more intense at the level of sires of sons. Between 13% and 67% of the progeny tested bulls had a foreign sire (Table 2). Selection of sires of sons is most global for the Brown Swiss and Holstein breed groups. The trend is generally increasing, particularly for the Guernsey and Jersey breed groups. Similar patterns were observed for the origin of maternal grand sires of progeny tested bulls.

By comparing table 1 and table 2 it becomes clear that, not surprisingly, the exchange of semen at the level of sires of sons is more frequent than the importation of calves to be put on progeny test. Fikse *et al.* (2006) reported that the proportion of foreign proven bulls used to breed cows for the commercial population ranged from 3% to 12%, with large variations between countries, and the impact of semen exchange at the level of proven bulls is less than that for sires of sons.

Table 1. Percentage of bulls progeny tested<sup>1</sup> in country of origin<sup>2</sup>.

Breed group	Birth year of bull		
	1981-1985	1986-1990	1991-1995
Brown Swiss	93.2	94.7	94.6
Guernsey	96.1	88.5	84.9
Holstein		89.1	86.4
Jersey	98.1	95.6	94.5
Red Dairy Cattle	97.4	98.6	99.3
Simmental	97.9	98.4	97.3

<sup>1</sup>Country of test is defined as the country with most daughters.

<sup>2</sup>Origin is defined as country of first registration.

Table 2. Percentage of progeny tested bulls with foreign sire.

Breed group	Birth year of bull		
	1981-1985	1986-1990	1991-1995
Brown Swiss	67.3	57.4	64.9
Guernsey	14.6	13.0	32.7
Holstein		60.2	59.4
Jersey	14.9	26.1	35.0
Red Dairy Cattle	16.7	27.1	26.9
Simmental	23.6	26.0	28.6

## Importance of Broad Breeding Objectives

There is accumulating evidence that single-trait selection for milk production has negative side-effects on the health and reproduction of dairy cows. These functional traits, i.e. characters of an animal that increase efficiency not by higher outputs of products but by reduced costs (Groen *et al.*, 1997), are unfavorably correlated with milk production, the magnitude of the genetic correlations being 0.2-0.5 (e.g. Roxström, 2001; Wall *et al.*, 2003). The complexity of functional traits, reflected in the categorical nature of data records and low heritabilities, is often given as a reason to ignore these traits in breeding objectives and breeding programs.

The considerable amount of genetic variation that exists for functional traits (Philipsson and Lindhé, 2003) justifies inclusion of these traits in breeding objectives. Aamand (2007) illustrated for example that the incidence of mastitis was about twice as high among daughters of sires with an index below 86 (2 SD below average) compared to sires with an index above 113 (2 SD above average). Zwald *et al.* (2004) also reported large differences in incidence (by a factor of between 1 and 5) of several diseases (ketosis, mastitis, lameness, cystic ovaries and metritis) depending on the genetic merit for disease susceptibility.

The merging of Nordic health and reproduction data with North American production and conformation data revealed an unfavorable relationship between health and dairy character (Rogers *et al.*, 1999). The emphasis on dairy character and the determination to breed for 'sharp' cows may indeed have contributed to the increase in health and reproductive problems in some breeds.

Given the existence of genetic variation and the negative relationship with production, ignoring functional traits will lead to deterioration of functional traits and ultimately an increase in costs of producing milk due to increased disease incidence, reproductive failures and involuntary culling of cows. On average, the length of productive life is 2-3 lactations. This measure must, however, be cautiously interpreted as it merely reflects the economics of markets and the production systems practiced rather than just the genetic stayability of the cows. The emphasis of dairy cattle breeding objectives has gradually shifted from production and conformation traits only to include more functional traits during the past couple of decades (Miglior *et al.*, 2005) and

many countries now have genetic evaluations in place for important functional traits such as health, fertility, longevity and calving traits (Mark, 2004).

The inclusion of functional traits in selection indexes and breeding objectives not only increases genetic progress for total genetic merit in economic terms but has also positive implications for genetic diversity. Sorensen *et al.* (1999) observed with simulations that selection for milk yield was inferior to selection for total merit index in terms of genetic gain for total genetic merit and inbreeding rates.

## Interbull International Genetic Evaluations

Traditionally, countries perform national genetic evaluations to assess the genetic merit of bulls, but the results of these evaluations are not directly comparable across countries. The main reasons (Philipsson, 1987) are

1. Differences in trait definitions and recording and evaluations practices.
2. Differences in genetic levels among countries.
3. Differences in animal performance under varying production systems (genotype-environment interaction).

It was nearly impossible for breeders to compare the genetic merit of domestic and foreign genetic material, complicating the process of identifying superior animals and realizing the potential benefits of exchange of genetic material between countries. The recognition of this problem formed the basis of developments and activities, initially by EAAP and IDF, that led to the establishment of Interbull and the launch of international genetic evaluations by Interbull.

## MACE

The routine international genetic evaluations performed by Interbull combine the results of national genetic evaluations from various countries in a joint analysis often referred to as Multiple-trait Across Country Evaluation (MACE; Schaeffer, 1994). MACE is essentially a multiple-trait sire model where performance in each country is treated as a different trait. Important features of MACE are the ability to accommodate different parameters (heritability, genetic and residual variances) between countries and the possibility of considering relationships between bulls.

Genetic correlations between countries are accounted for in MACE to reflect the fact that performance in different environments can be viewed as different traits. Genetic correlations between countries less than unity indicate the presence of genotype-environment interaction, which means that ranking of animals (genotypes) differs between countries (environments). For example, if cows are fed on high quality feed then the cows' appetite and feed intake could be the factor that causes some cows to be superior in milk production over others, whereas if the cows are fed on poor feed it is likely that cows with the best feed utilization will be superior. Hence, a separate list of bulls with breeding values is computed for each participating country, expressed in their own units and relative to their own base group of animals (Figure 2).

### Genetic correlations between countries

Genetic correlations between countries are on average highest for milk production and somatic cells and lowest for longevity and stillbirth (Table 3). These correlations reflect on one hand the harmonization in recording and evaluation of traits and on the other hand the degree of genotype-environment interaction between countries. Both milk yield and somatic cells are recorded and evaluated reasonably uniformly across countries, which is reflected in the high

genetic correlations between countries. Longevity, on the other hand, is a more complex trait and genetic correlations between countries are relatively low and variable. Reasons for culling differ between countries due to economic conditions, climate and other production factors.

A closer look at the genetic correlations reveals that correlations are usually highest among countries in the same hemisphere and lowest among countries from different hemispheres (North vs. South). For example, the genetic correlations for milk production among countries from the same hemispheres range between 0.85 and 0.95, and are between 0.75 and 0.85 among countries from different hemispheres. Thus, milk production in the northern and southern hemispheres can be viewed as different traits, and different rankings of sires are to be expected in both hemispheres.

### Global perspective on selection of dairy bulls

A consequence of genotype-environment interaction and genetic correlations among countries less than unity, is the re-ranking of animals across environments (illustrated in Figure 2). Table 4 is based on data available through Interbull and shows that bulls with high genetic merit for protein yield in Sweden, USA or the Netherlands do not always have high genetic merit for protein yield in

Table 3. Weighted<sup>1</sup> average and range in estimated genetic correlations ( $r_g$ ) across different Holstein populations for selected traits (February 2007).

Trait	Populations	Mean $r_g$	SD of $r_g$	Range of $r_g$
Protein yield	24	0.84	0.05	0.18
Somatic cells	23	0.90	0.05	0.23
Clinical mastitis <sup>2</sup>	4	0.85	0.07	0.18
Longevity	19	0.71	0.14	0.61
Direct calving ease	12	0.78	0.11	0.51
Maternal calving ease	11	0.77	0.09	0.35
Direct stillbirth	5	0.69	0.11	0.29
Maternal stillbirth	5	0.80	0.07	0.21
Interval calving-first insemination	5	0.81	0.17	0.43
Non-return rate	5	0.74	0.09	0.32
Days open/calving interval	8	0.81	0.10	0.34
Body condition score <sup>3</sup>	2	0.92		

<sup>1</sup>Weighted by number of bulls with evaluations in both of the concerned countries.

<sup>2</sup>Taken from the Interbull March 2005 test evaluation.

<sup>3</sup>Estimated by Jorjani (2005).

Table 4. Number of bulls in common between the top 100 lists of Holstein bulls on four different country scales<sup>1</sup>.

	Protein			Somatic cells			Longevity		
	NLD	USA	NZL	NLD	USA	NZL	NLD	USA	NZL
SWE	86	90	80	75	70	39	41	46	0
NLD		82	75		69	41		48	0
USA			75			34			3

<sup>1</sup> NLD = The Netherlands; SWE = Sweden; USA = United States of America; NZL = New Zealand

Table 5. Increase in total number of top 100 bulls when considering genotype-environment interaction by applying genetic correlations ( $r_g$ ) less than unity (February 2007).

Breed group	Number of populations	Number of top bulls	
		$r_g = 1$	$r_g < 1$
Brown Swiss	9	100	179
Guernsey	6	100	140
Holstein	24	100	309
Jersey	10	100	282
Red Dairy Cattle	10	100	192
Simmental	10	100	179

New Zealand. The top 100 lists of the northern hemisphere countries had approximately 90 bulls in common, but only 75-80 with New Zealand. The situation is more extreme for somatic cells and especially longevity for which none of the top 100 bulls in Sweden and the Netherlands were among the top 100 in New Zealand (Table 4). It appears that due to the seasonal calving patterns and the grazing system, cows have to meet different requirements to survive in New Zealand compared with northern hemisphere countries.

Considering genotype-environment interaction in international comparisons leads to the selection of more bulls on a global level (Table 5). For example, treating protein yields as different traits in each of the 24 populations participating in the Interbull evaluation (Holstein), 309 different bulls were among the top 100 in any given country. Similarly, there were 611 different bulls among the top 100 lists for longevity in each of the 19 countries (Holstein). Different sires and dams are selected in different countries, which can increase the global effective population size (Goddard, 1992). Thus, taking genotype-environment interaction into account in international comparisons has a desirable effect on the utilization of animal genetic resources, in addition to accommodating differences in production environments around the world.

The number of potential selection candidates increases when selection is across-country rather

than within-country. Consequently, higher selection intensities can be achieved which is especially beneficial for small and genetically inferior populations (Banos and Smith, 1991; Lohuis and Dekkers, 1998). Using the Interbull evaluation results it has been shown that the potential to increase selection differentials is up to 2.5 genetic standard deviation units for across-country selection compared to within-country selection (Fikse, 2004; Mark, 2005). Rather than exploiting the increased selection potential for increasing genetic progress, it can also be used to select less-related animals, thus reducing the inbreeding rate.

The combination of 1) genotype-environment interactions for individual traits and 2) differences in breeding objectives across countries (i.e. weights given to individual traits in an index for total genetic merit) results in relatively low genetic correlations between breeding objectives in different countries. Sonesson (2006) estimated the genetic correlation between the breeding objectives for the Nordic Red breeds to be around 0.8. Miglior *et al.* (2005) observed rather low numbers of bulls in common between the top 100 lists for total genetic merit in a range of countries, indicating considerable re-ranking of bulls across countries.

The presence of genotype-environment interaction for total genetic merit actualizes the question of whether separate breeding programs should be maintained for different environments

and whether cooperation between breeding programs is beneficial. Sonesson (2006) investigated the difference between one breeding program for all countries and separate breeding programs in each country for the Nordic Red breeds and concluded there was little difference in overall genetic gain at constrained levels of inbreeding rate. A general rule-of-thumb is that multiple breeding programs are justifiable when the genetic correlation between breeding objectives is below 0.8 (e.g. Robertson, 1959), but this depends on the actual scenario (testing capacity, genetic parameters, selection intensity, etc.; Mulder and Bijma, 2006).

### Interbull evaluations

Interbull started international genetic evaluations for production traits in 1994 and data from four countries and two breed groups were considered (Philipsson, 1998). Since then, Interbull services have expanded and they nowadays consider six breed groups and 26 countries (Table 6). Since February 2007, international evaluations for fertility have been computed, in addition to production, conformation, udder health, longevity and calving performance. Thus, international genetic evaluations are available for all economically important trait groups.

Routine evaluations are performed three times per year. For the Interbull evaluation of February 2007 the pedigree database included nearly 400 000 bulls (Table 7) and international evaluations were computed for 140 000 bulls. It should be noted that Interbull does not publish international breeding values; Interbull simply distributes them to participating countries. It is then the responsibility of these countries to rank the bulls within country according to their own breeding objectives, and publish these results.

The joint analysis of national genetic evaluations (MACE) depends on the results of national genetic evaluations systems (Figure 2). Therefore, international comparisons are only as good as the various national evaluation systems that provide the input. Procedures have been developed and are applied on a regular basis to check the quality of data used in Interbull evaluations (Klei *et al.*, 2002; Boichard *et al.*, 1995). In addition, Interbull organizes special workshops, conducted surveys and compiled guidelines for national genetic evaluation systems to monitor developments and promote standardization of national evaluation systems and their results.

## Monitoring Global Trends in Dairy Cattle Breeding

### Genetic progress

The genetic level for protein yield has increased noticeably during the past two decades for both the Holstein and Red Dairy cattle breed groups (Figure 3). The genetic trends were slightly negative (unfavorable) for clinical mastitis and direct longevity for the Holstein breed group. On the other hand, the genetic trend for clinical mastitis and direct longevity for the Red Dairy cattle breed group were slightly positive.

Philipsson and Lindhé (2003) illustrated the importance of having comparable information for all traits of economic importance for selection candidates by comparing the genetic trend in female fertility for the Swedish Holstein and the Swedish Red populations. The genetic trend for fertility in the Swedish Red population was slightly favorable, due to the availability of genetic evaluations for progeny tested bulls that were candidates for selection as sires of sons. The majority (~75%) of the bulls belonging to the Red Dairy cattle breed group are tested in Nordic countries where recording and evaluation of female fertility traits has been practiced for a long time. The situation for the Holstein breed group was much worse, because at the time of selection as sires of sons no female fertility information was available for the majority of bulls (> 90%). Selection emphasis was instead put on production and conformation, leading to an unfavorable correlated response for female fertility.

### Inbreeding

The intensity of use of sires of sons has been highest for the Holstein breed group, as indicated by the number of sons per bull sire (Figure 4). For the other breed groups about ten sons per bull sire were tested on average. The oscillating pattern for the Holstein breed group is caused by a few very popular bull sires with hundreds or thousands of progeny tested sons. In 1983 and 1985, half of all progeny tested bulls were sired by one bull sire. Extreme use of Holstein bull sires has been tempered for bulls born after 1987 (Figure 5). For the Jersey breed group the intensity of use of bull sires has been tempered lately as well, whereas the trend is increasing for the Brown Swiss breed group. Due to the limited population size not more than five

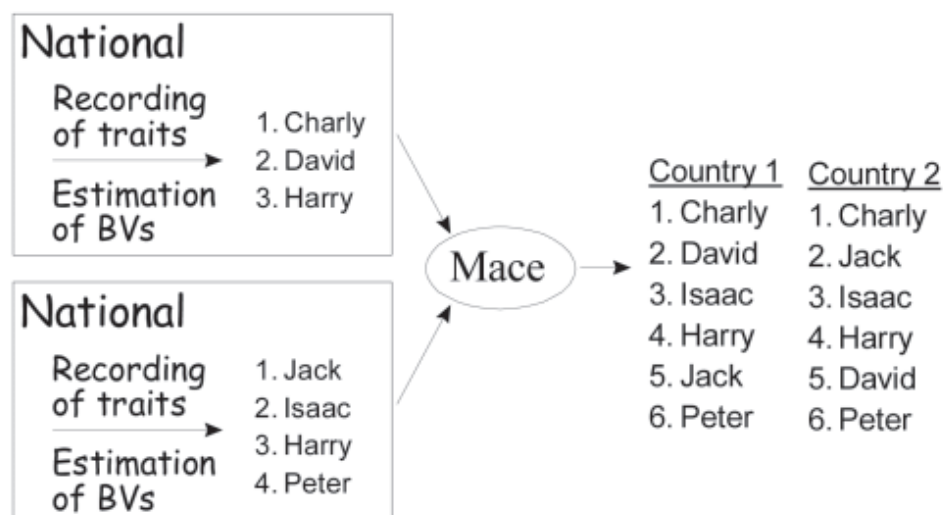


Figure 2. Schematic illustration of the international genetic evaluation model.

Table 6. Number of populations participating in the routine Interbull evaluation of February 2007.

Breed group	Production	Conformation	Udder health	Longevity	Calving	Female fertility
Brown Swiss	9	7	8	6	4	-
Guernsey	6	4	5	5	-	-
Holstein	24	20	23	19	12	11
Jersey	10	9	8	7	-	-
Red Dairy Cattle	10	8	10	9	5	-
Simmental	10	-	8	2	-	-
Total	69	48	62	48	21	11

Table 7. Number of bulls in pedigree database and bulls with publishable breeding values for production by breed group (February 2007).

	Pedigree database	Publishable breeding value for production
Brown Swiss	59 131	7 249
Guernsey	2 315	892
Holstein	226 357	95 629
Jersey	19 448	7562
Red Dairy Cattle	29 703	10 945
Simmental	33 816	19 980

Guernsey bull sires are selected annually, leading to the high number in figure 5.

In the last decade a multitude of studies have reported inbreeding trends and inbreeding depression in the major dairy breeds. Based on the inbreeding rate, Weigel (2001) estimated the effective population size at 161, 61, 65, 39, and 30

for the US Ayrshire, Brown Swiss, Guernsey, Holstein, and Jersey populations, respectively. Recent estimates based on Danish pedigree information were 49 and 53 for Holstein and Jersey, respectively, and a decrease was predicted for the immediate future (Sorensen *et al.*, 2005). Inbreeding is now at a level where the effects become

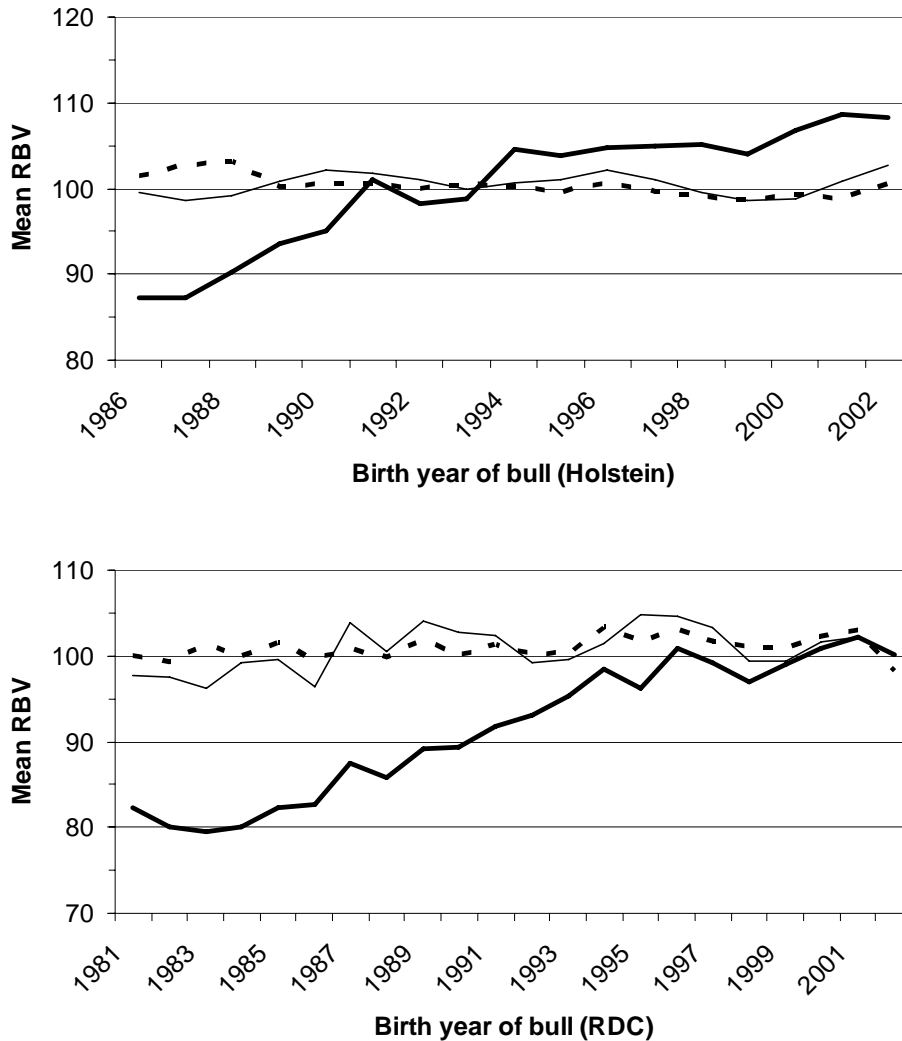


Figure 3. Estimated genetic trends in Holstein and Red Dairy cattle cow populations for protein yield (thick-solid line), clinical mastitis (dotted line) and direct longevity (thin-solid line) on Swedish scales (weighted average of international bull breeding values from February 2007 Interbull evaluations; weighted by total number of daughters across all countries; high breeding values are favorable; all breeding values are expressed with a standard deviation of 10).

noticeable, for example by the increased problems due to recessive genetic defects or inbreeding depression.

Dairy farmers in the US and other countries started to explore crossbreeding Holsteins with other breeds (Hansen, 2006) to circumvent problems due to increased inbreeding rates and deterioration of functional traits. The first experiences from these crossbreeding experiments are positive, resulting in F1 females with lower stillbirth rates, decreased calving difficulty, improved cow fertility, and enhanced survival with little, if any, loss of

production (kg) of fat plus protein (Heins *et al.*, 2006a; 2006b; 2006c). The prospects of crossbreeding as a means to deal with problems in purebred populations depends on the implementation of crossbreeding programs on a herd basis that capture as much heterosis as possible, are easy to manage and result in as little variation among crossbred animals as possible. Most importantly, crossbreeding is only successful if continuous progress is made in the purebred populations.



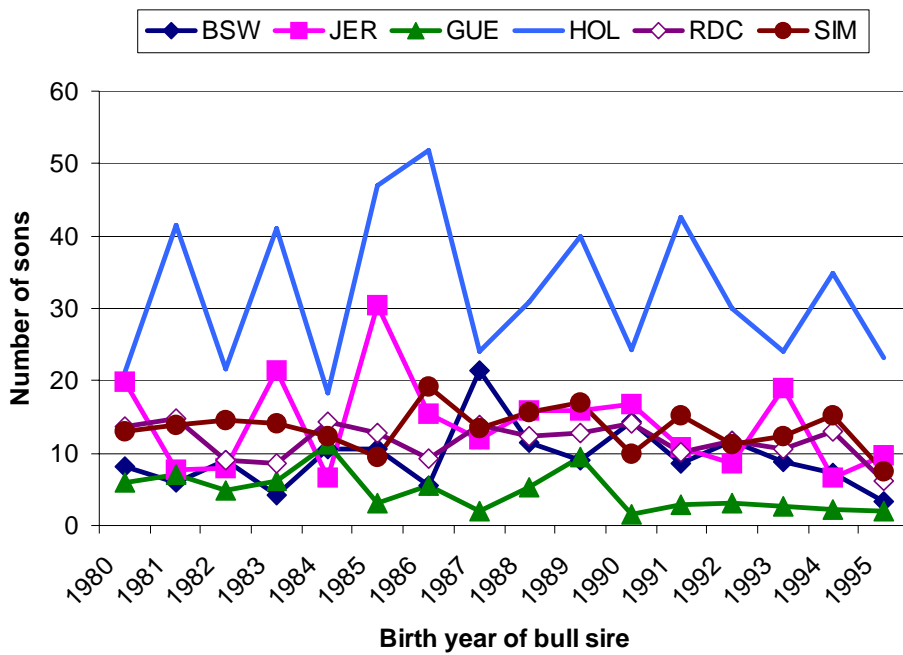


Figure 4. Average number of progeny tested sons per bull sire (February 2007).

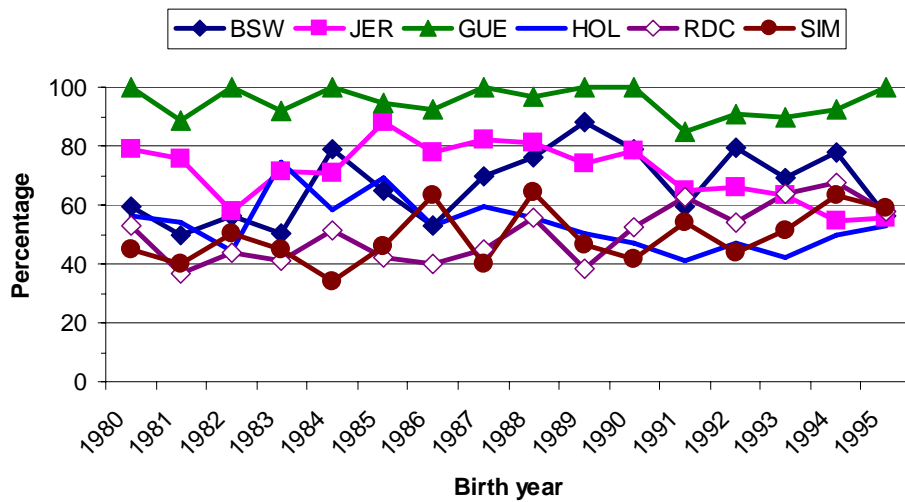


Figure 5. Percentage progeny tested bulls after the five most popular bull sires (February 2007).

Several tools to aid selection of parents have been developed that can maximize progress at restricted inbreeding rates (Meuwissen and Sonesson, 1998; Berg *et al.*, 2006). While powerful, the success of these tools depends on the extent of their use. Important selection decisions in dairy cattle breeding (bull sire and bull dam selection) are taken by AI organizations that are in competition with each other. The challenge for these

organizations is to balance the short-term interest in increasing genetic gain with the long-term need to avoid depletion of genetic resources. Initiatives like the European Forum of Farm Animal Breeders and the development of a Code of Good Practice for Farm Animal Breeding and Reproduction Organizations are steps in the right direction.

## Measures to be taken for sustainability

A sustainable dairy cattle breeding program should be characterized by:

- A continuous genetic improvement of productivity to keep the population commercially competitive in relevant areas for production.
- The generation of products which have such value that they are marketable at a profitable farm-gate price.
- A broad definition of breeding objectives to take into account selection for all major economically important traits with a special restriction that fundamental characteristics of fertility, health and survival do not decline.
- Management of inbreeding at such a level that no depression of important traits resulting from increased inbreeding occurs. The effective population size should be monitored and selection practiced to keep it above levels at which the breed is considered to be at risk of endangerment.

In any dairy cattle population the most important assumption for a sustainable breeding program is that there is a comprehensive milk-recording scheme and links to other recordings of traits, e.g. health and fertility, to enable genetic evaluation of bulls for broad breeding objectives (Philipsson *et al.*, 2005).

As regards the design of breeding programs, the use of young bulls is essential in all systems. In large populations extensive use of young bulls enables progeny testing of many bulls, providing opportunities for strong selection of bulls to be used as sires of cows and sons. With large progeny groups, i.e. 100-150 daughters, reasonably accurate breeding values can also be obtained for most functional traits. In small populations progeny testing is of limited value for selection of bulls for wide-spread use, as such use is not possible from an inbreeding point of view. However, progeny information, as well as records of all relatives, can be used for evaluation and selection of parents of young bulls, each one of which should be limited in use.

The globalization of practically all breeds is a fact and the advantages of this should be captured while possible disadvantages must be avoided. To reach this goal it is important that all bulls in the countries in question are evaluated nationally (or regionally) for domestically defined broad breeding objectives and that these domestic breeding values become part of the international genetic evaluations that Interbull provides. In this way wise selection of

bulls across countries is made possible for the broad breeding objectives set for each country (or region). This scenario is based on the assumption that the Interbull evaluations are published in each country in such a way that they are easily accessible by AI stud managers and progressive farmers.

## Options for developing countries

Livestock recording schemes are well developed in most industrialized countries and may then provide the information necessary to conduct advanced genetic evaluations of cows and bulls. In most developing countries the situation is quite different. The most limiting factor for adoption of sustainable breeding programs is the lack of relevant recording schemes as a basis for both management and genetic evaluation purposes (Philipsson, 2000). For local breeds, variants of nucleus breeding schemes are plausible, but problems exist in selecting bulls of 'exotic' breeds, e.g. Holstein, Brown Swiss and Ayrshire. If no domestic evaluations exist in the developing countries, there are no opportunities to participate in international evaluations, and thus to select the best bulls for the country in question. The best advice so far is for each country to compare its environment and production system with those countries already participating in the Interbull evaluations and rely on the results of a country having the most similar environment. For instance, international breeding values published for New Zealand may indicate which bulls are best for other countries heavily relying on grazing systems, whereas Israeli results may be the best to use in other countries characterized by a hot climate and high intensity of grain feeding. In any case, breeding organizations in developing countries need to put more emphasis on defining their own breeding objectives and select for these according to the principle proposed above, rather than just using semen of any bulls advertised by foreign companies.

## Do Commercial Breeds Need to Be Conserved?

In scrutinizing the criteria for sustainability of breeding programs for dairy cattle, and the review of what has happened in the most globally prominent breeds used for dairy production, it is obvious that certain facts indicate that some breeds, especially Holstein, are faced with severe problems that question the sustainability of the breed. The

unfavorable correlations between e.g. production and fertility, or the rising stillbirth trend, have not been met globally by adequate means for genetic evaluation and selection until very recently. Still, for these breeds used globally there is no body that takes the overall responsibility for directing their development into more harmonized breeding programs in line with the criteria for sustainability rather than focusing on traditional breeding for conformation, and especially for such traits that are unfavorably correlated with fitness of the animals. However, there are notable exceptions. In Scandinavia, quite well harmonized breeding programs have long since been established for the Red Dairy breeds, considering broad breeding objectives. As a consequence semen of these breeds is now successfully used internationally in crossing Holsteins to capture not only effects of heterosis, but also to effectively incorporate genes for good fertility and health along with high production and to avoid further inbreeding (Hansen, 2006).

Another example and problem is demonstrated by the Guernsey breed, which has been declining in numbers for some time. In most countries the breeding program is characterized by traditional selection for just production and conformation, the latter leading to bigger and less fertile cows. However, the World Guernsey Cattle Federation has taken the initiative to launch a global breeding program based on sound scientific principles, whereby the genetic diversity is considered in combination with selection for a continuously broader breeding objective (Luff, 2006). It takes time, however, to harmonize ideas and breeding objectives and principles of selection across continents used with different breeding traditions, but such global efforts are very well worth supporting. This is also emphasized by the fact that the breed seems to offer certain characteristics in its milk that differ from other major breeds.

## List of References

- Aamand, G.P.** 2007. Use of health data in genetic evaluation and breeding. Proceedings of the 35<sup>th</sup> Biennial session of ICAR. EAAP publication no. 121: 275-282.
- Banos, G. & C. Smith.** 1991. Selecting bulls across countries to maximize genetic improvement in dairy cattle. *Journal of Animal Breeding and Genetics* 108: 174-181.
- Berg, P., J. Nielsen & M.K. Sorensen.** 2006. EVA: realized and predicted optimal genetic contributions. Proceedings of the 8<sup>th</sup> World Congress on Genetics Applied to Livestock Production, communication no. 27-09.
- Boichard, D., B. Bonaiti, A. Barbat & S. Mattalia.** 1995. Three methods to validate the estimation of genetic trend for dairy cattle. *Journal of Dairy Science* 78: 431-437.
- Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui & C. Courbois.** 1999. Livestock to 2020-The next food revolution. Food, Agriculture, and the Environment Discussion Paper 28. IFPRI (International Food Policy Research Institute), Washington, DC, USA, pp. 72.
- Fikse, W.F.** 2004. Interbull guides through the labyrinth of national genetic evaluations. Proceeding of the 55<sup>th</sup> meeting of the EAAP. EAAP Book of Abstracts 10, 326.
- Fikse, W.F., J.H. Jakobsen & C. Gustafsson.** 2006. Selection of sires in different countries for global dairy breeds. Proceedings of the 8<sup>th</sup> World Congress on Genetics Applied to Livestock Production, communication no. 01-31.
- Groen, A.F., T. Steine, J.J. Colleau, J. Pedersen, J. Pribyl & N. Reinsch.** 1997. Economic values in dairy cattle breeding, with special reference to functional traits. Report of an EAAP-working group. *Livestock Production Science* 49:1-21.
- Goddard, M.E.** 1992. Optimal effective population size for the global population of black and white dairy cattle. *Journal of Dairy Science* 75: 2902-2911.
- Hansen, L.B.** 2006. Monitoring the worldwide genetic supply for cattle with emphasis on managing crossbreeding and inbreeding. Proceedings of the 8<sup>th</sup> World Congress on Genetics Applied to Livestock Production, communication no. 01-01.
- Heins, B.J., L.B. Hansen & A.J. Seykora.** 2006a. Production of pure Holsteins versus crossbreds of Holstein with Normande, Montbeliarde, and Scandinavian Red. *Journal of Dairy Science* 89: 2799-2804.

- Heins, B.J., L.B. Hansen & A.J. Seykora.** 2006b. Calving difficulty and stillbirths of pure Holsteins versus crossbreds of Holstein with Normande, Montbeliarde, and Scandinavian Red. *Journal of Dairy Science* 89: 2805-2810.
- Heins, B.J., L.B. Hansen & A.J. Seykora.** 2006c. Fertility and survival of pure Holsteins versus crossbreds of Holstein with Normande, Montbeliarde, and Scandinavian Red. *Journal of Dairy Science* 89: 4944-4951.
- Klei, L., T. Mark, W.F. Fikse & T. Lawlor.** 2002. A method for verifying genetic evaluation results. *Interbull Bulletin* 29: 178-182.
- Lohuis, M.M. & J.C.M. Dekkers.** 1998. Merits of borderless evaluations. *Proceedings of the 6<sup>th</sup> World Congress on Genetics Applied to Livestock Production* 26: 169-172.
- Luff, B.** 2006. Guernsey Global Breeding Programme. <http://www.worldguernseys.org/>.
- Mark, T.** 2004. Applied genetic evaluations for production and functional traits in dairy cattle. *Journal of Dairy Science* 87: 2641-2652.
- Mark, T.** 2005. International genetic evaluations for udder health traits in dairy cattle. PhD thesis. *Acta Universitatis Agriculturae Sueciae*, 2005: 93. Swedish University of Agricultural Sciences, Uppsala, Sweden.
- Meuwissen, T.H.E. & A.K. Sonesson.** 1998. Maximizing the response of selection with a predefined rate of inbreeding- overlapping generations. *Journal of Animal Science* 76: 2575-2583.
- Miglior, F., B.L. Muir & B. J. Van Doormaal.** 2005. Selection indices in Holstein cattle of various countries. *Journal of Dairy Science* 88: 1255-1263.
- Mulder, H.A., R.F. Veerkamp, B.J. Ducro, J.A.M. van Arendonk & P. Bijma.** 2006. Optimization of dairy cattle breeding programs for different environments with genotype by environment interaction. *Journal of Dairy Science* 89: 1740-1752.
- Philipsson, J.** 1987. Standards and procedures for international genetic evaluation of dairy cattle. *Journal of Dairy Science* 70: 418-424.
- Philipsson, J.** 1998. Global use of bulls and the "INTERBULL System". *Agric. Scand., Sect. A, Animal Science* 1998: Supplement 29: 98-107.
- Philipsson, J.** 2000. Sustainability of dairy cattle breeding systems utilising artificial insemination in less developed countries-examples of problems and prospects. *ICAR Technical Series* no. 3: 551-562.
- Philipsson, J., J-Å. Eriksson & H. Stålhammar.** 2005. Know-how transfer in animal breeding-the power of integrated cow data bases for farmer's selection of bulls to improve functional traits in dairy cows. In: *Knowledge transfer in cattle husbandry*. EAAP Publication no. 117: 85-95.
- Philipsson, J. & B. Lindhé.** 2003. Experiences of including reproduction and health traits in Scandinavian dairy cattle breeding programmes. *Livestock Production Science* 83: 99-112.
- Robertson, A.** 1959. The sampling variance of the genetic correlation coefficient. *Biometrics* 15: 469-485.
- Rogers, G.W., G. Banos & U.S. Nielsen.** 1999. Genetic correlations among protein yield, productive life, and type traits from the United States and diseases other than mastitis from Denmark and Sweden. *Journal of Dairy Science* 82: 1331-1338.
- Roxström, A.** 2001. Genetic aspects of fertility and longevity in dairy cattle. PhD thesis. *Acta Universitatis Agriculturae Sueciae, Agraria* 276. Swedish University of Agricultural Sciences, Uppsala, Sweden.
- Schaeffer, L.R.** 1994. Multiple-country comparisons of dairy sires. *Journal of Dairy Science* 77: 2671-2678.
- Sonesson, A.K.** 2006. Assessing total profit of alternative levels of co-operation between Nordic cattle populations. In: *Project report: Sustainable Breeding in the Nordic Red Dairy Breeds*.
- Sorensen, M.K., P. Berg, J. Jensen & L.G. Christensen.** 1999. Stochastic simulation of breeding schemes for total merit in dairy cattle. *Interbull Bulletin* 23: 183-192.
- Sorensen, A.C., M.K. Sorensen & P. Berg.** 2005. Inbreeding in Danish dairy cattle breeds. *Journal of Dairy Science* 88, 1865-1872.

.....

**Stolzmann, M., H. Jasiorowski, Z. Reklewski, A. Zarnecki & G. Kalinowska.** 1981. Friesian cattle in Poland. Preliminary results of testing different strains. *World Animal Review*, 38: 9-15.

**Wall, E., S. Brotherstone, J.A. Woolliam, G. Banos & M.P. Coffey.** 2003. Genetic evaluation of fertility using direct and correlated traits. *Journal of Dairy Science* 86: 4093-5102.

**Weigel, K.A.** 2001. Controlling inbreeding in modern breeding programs. *Journal of Dairy Science* 84 (E. supplement): E177-E184.

**Zwald, N.R., K.A. Weigel, Y.M. Chang, R.D. Welper & J.S. Clay.** 2004. Genetic selection for health traits using producer-recorded data. I. Incidence rates, heritability estimates, and sire breeding values. *Journal of Dairy Science* 87: 4287-4294.



# Genetic diversity and sustainable management of animal genetic resources, globally

*E. Finland*

*Nordic Gene Bank Farm Animals, Department of Animal and Aquacultural Sciences,  
P.O. Box 5003, 1432 Aas, Norway*

## Summary

General trends of development imply an increasing uniformity of animal genetic resources, caused by the loss of endangered breeds and increased inbreeding within commercial breeding populations. The implications of these trends point to a reduction in the genetic diversity of the animal genetic resources, which may reduce possibilities for utilization in the future, while at the same time a dramatic change in environmental production conditions can be observed. In order to change this developmental trend, sustainable management of animal genetic resources must be promoted globally. The fundamental issues for such sustainable management are illustrated by the principles given in the Convention on Biological Diversity. In order to accomplish sustainable management of these resources, the following actions must be taken:

- The development of policies to promote national and global responsibility for maintaining genetic diversity, which will not be addressed within this paper
- The development of knowledge as a fundamental concept to impose sustainable management principles on these animal genetic resources. This will be dealt with in this paper. A more complete description of these features can be found in Woolliams *et al.*, 2005 in (Sustainable Management of Animal Genetic Resources).

## Résumé

Les tendances générales de développement actuel prévoient une uniformité des ressources génétiques animales, due, d'une part, à la perte des espèces menacées d'extinction et d'autre part, au développement des croisements génétiques au sein des populations commercialisées pour l'élevage.

Ceci mène à une restriction de la diversité génétique des ressources animales, ce qui pourrait compromettre leur utilisation possible à l'avenir. A côté de cela, les conditions environnementales de production sont également radicalement changeantes. Pour pouvoir faire évoluer ce mode de développement de manière positive, il est plus que nécessaire d'imposer un management durable des ressources génétiques animales, à l'échelle mondiale. Le fondement d'un tel développement durable est mis en avant par les principes cités par la Convention sur la Biodiversité. Pour atteindre un management durable de ces ressources, certaines conditions sont nécessaires:

- Une responsabilité à la fois nationale et internationale pour conserver la diversité génétique - règles, qui ne seront pas traitées dans ce document
- Développer les connaissances, fondement de base pour imposer le développement durable de ces ressources génétiques animales; sujet qui sera débattu ici. Une plus complète description de ce dispositif peut être consultée dans Woolliams *et al.*, 2005 (Sustainable Management of Animal Genetic Resources).

## Resumen

Las tendencias generales de desarrollo actualmente preven una uniformidad de los recursos zoogenéticos debido, por una parte a la pérdida de especies en vía de extinción y por otra al desarrollo de cruces genéticos dentro de las poblaciones para comercialización. Esto nos lleva a una restricción de la diversidad genética de los recursos animales, lo que podría comprometer su utilización en el futuro. Al mismo tiempo las condiciones ambientales de producción también están cambiando radicalmente. Para permitir la evolución de este tipo de desarrollo de manera positiva, será necesario imponer una gestión sostenible de los recursos zoogenéticos a escala mundial. La base de este desarrollo

sostenible se recoge dentro de los principios estipulados en la Convención para la Biodiversidad. Para alcanzar una gestión sostenible de estos recursos son necesarias ciertas condiciones:

- Responsabilidad tanto nacional como internacional para la conservación de la diversidad genética – normas que no trataremos en este documento.
- Desarrollar los conocimientos y los fundamentos de base para imponer un desarrollo sostenible de estos recursos zootécnicos, este tema será tratado en el artículo. Una descripción más detallada de este dispositivo se puede consultar en Wooliams, J.A. *et al.* 2005. Sustainable Management of Animal Genetic Resources. Nordic Gene Bank Farm Animals ISBN 92-893-1089-8.

**Keywords:** *Animal genetic resources, Sustainable management, Maintain genetic diversity, Optimal selection, Conservation.*

## Introduction

In addition to maintaining diversity, the Convention on Biological Diversity (CBD) also intends to activate genetic resources (GR) for food production, which may impact on the sustainable management of all farm AnGR, including:

- Sustainable useage.
- Sufficiency of conservation.
- Fair and equitable sharing of benefit.
- National responsibility.

The objectives of the CBD can be accomplished in two ways: via political incentives and/or directives/acts on the one hand; and through knowledge, analysis of future consequences and invention of technological tools to avoid damage caused by insufficient breeding programmes on the other. In addition, sufficient conservation of endangered breeds must be undertaken in such a way that genetic diversity among breeds can be maintained.

The Nordic Gene Bank Farm Animals (NGH) focuses on developing the knowledge needed to accomplish the sustainable management of AnGR, based on extensive cooperation with, among others:

- National ministries of agriculture.
- National gene resource committees or other bodies appointed by the national authorities to organise the national conservation of AnGR, within the scope of available budgets.

- National breeding organisations, breed societies, etc.

NGH has directed increasing focus towards the elements needed to secure sustainable management of AnGR.

## Elements Needed for Sustainability

The following factors influence sustainable management of AnGR:

- Inbreeding,  $DF = 1/N_e$  a function of the efficient population size.
- Maintaining alternative breeds.
- Selection on a complete set of traits.
- Interaction between environment (production systems) and genetic effects.

The first two points encompass the requirement of maintaining diversity of farm AnGR and can be accomplished by the following means:

1. Avoidance of inbreeding:
  - Optimal selection based on the contribution theory that needs are equal for all breeds.
  - Maintaining a sufficient number of breeds to secure between-breed diversity, which provide new genes for immigration/exchange from other breeds. This requires several alternative breeding populations.
2. Conservation of breeds:
  - Activating properties of certain breeds for developing branded food products.
  - Ensuring sufficient conservation to secure maintenance of important genes for future use.
  - Conservation of historical/culturally important breeds.
3. In order to maintain the population of farm animals as a healthy production unit, the breeding goal must encompass the traits of both marketable products and those important for the functionality of the individuals belonging to the population. This implies:
  - Weighting factors for the traits must counterbalance the negative response via genetic correlations with vital traits of functionality, or proper trait restriction must be used as a selection tool.
  - By using reproduction, health and survival traits in the selection goal properly, unexpected problems caused by rapid changes in the frequency of unfavourable alleles/deleterious genes may be avoided,



and inbreeding depression in fitness traits may also be reduced.

To illustrate the point, the realised  $\Delta G$  for mastitis in Norwegian Red is shown in figure 1. Breeding programs can be designed in a way that gives a positive response to such traits as mastitis. Similar responses can be shown for non-return rates and other health problems in the breed in this example.

4. The last important factor impacting sustainability is the occurrence of interaction between production systems and genotypes. An international 'regulation' of exchange of AnGR should focus on this interaction and its social and economic consequences for the recipient population in the long run.

It would seem appropriate to copy some of the principles of the national legislation relating to the trade of goods in several countries, which put responsibility on the seller to sell an appropriate product. Such requirements could easily be included in a standard agreement for transferring genetic material of farm animals.

When the testing of the breeding animals and the production of the offspring are performed in the same environment or in the same production system, the interaction between genotype and environment or production system can usually be ignored. However, when the offspring is exported, the environment in the importing country may be quite different from the test environment of the parents. Besides, a lack of adaptation of the breeds to the environment in the importing country might

have a negative effect on fitness traits leading to disappointing production figures. An international regulation of exchange of farm animal genetic resources should focus on the existence of possible interactions and the long-term social and economic consequences for the importing country. It might undermine the livelihood of farmers in the importing country. Such imports often result in the erosion of local livestock systems and often the livelihoods of entire groups of people are destroyed. It has to be realized that as much as 70% of the world's rural poor (approximately two billion people) keep livestock to meet the food demands of their families. In these communities, livestock diversity contributes in many ways to human survival and wellbeing (Drucker, 2002).

Increasing production volume may also increase waste output. The considerable volumes of waste produced by large-scale, high-density livestock operations can cause severe soil, water and air pollution (Cunningham, 2003). The most important pollutants giving rise to concern are nitrogen, phosphorous, various heavy metals and greenhouse gasses such as methane and nitrous oxide. If the recycling of manure and urine in agriculture is not firmly regulated, considerable environmental damage may arise. The strong focus on environmental issues in several countries may lead to regulations that minimize the output of wastes from livestock systems. Such regulations may require other genotypes than those favoured by the present breeding goals which focus on maximizing yield. This means that breeding

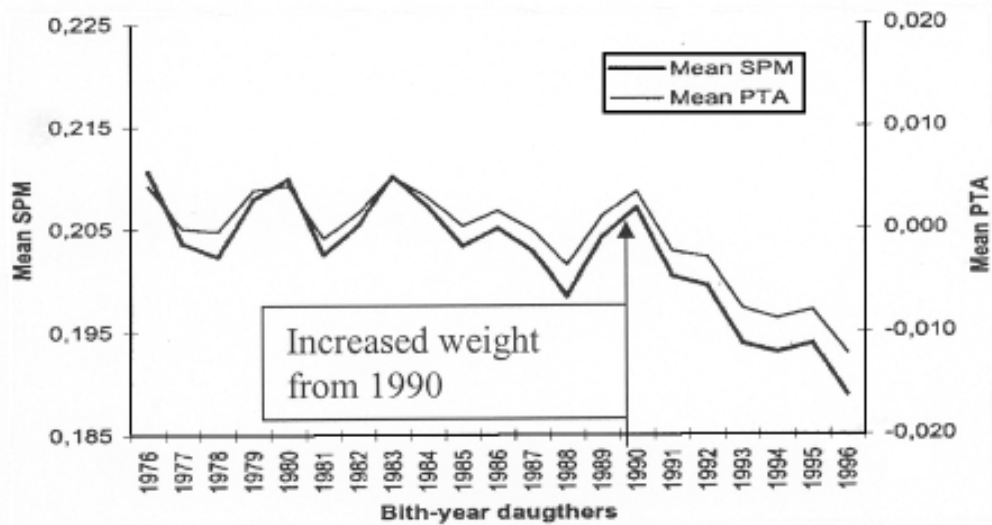


Figure 1. Plot of average sire posterior mean (SPM) in the probability scale (threshold model) and mean predicted transmitting ability (BLUP-PTA) of sires by birth-year of daughters for mastitis.

programmes that maximize production volume per animal may lead to a reduction of the environmental quality for that society.

## Food Security and Safety

Woolliams (2006) discusses the fundamental importance of farm animal genetic resources for food security and safety. The general answer is that livestock development works best when all strategies are co-ordinated and work in the same direction. For example, fertility in dairy cattle tends to decrease as milk yield increases. An established consequence of infertility is an increase in greenhouse gas emissions from the production system per litre of milk produced. The effectiveness of any management solution will be compromised when selection increases yield without taking into account the genetic merit for fertility. In this instance, the overall utility of the system will not be optimised (Woolliams 2006). Genetics can play an important role in the dynamics of the populations caused by genetic selection, and one should use genetic options, where they exist, as part of the solution to improve security and safety.

To meet the challenges to food security arising from the increased global demand and the threats from global warming, livestock breeding must be included as a component of the solution. In the long term, unsustainable management of animal genetic resources may lead to an increased risk to food security and safety.

## Knowledge as a Driving Force for Sustainability

Since the food coming from farm animals accounts for 40-50% of human caloric intake, and in many countries much of this food originates from the commercial or mainstream breeds, the maintenance of genetic diversity within these breeds is becoming increasingly important. As the number of breeds used in food production continues to decline, there is an increasing risk of some genetic failure. The loss of breeds contributing to our food supply directly diminishes the aspect of food security inherent in maintaining a diversity of food resources. Thus, major breeds which have “no alternative” for immigrant genes from other breeds, have to invest in tools and strategic measures to avoid the risk of genetic failure, as part

of the running breeding programme. Investments in risk management measures for running breeding programmes are not well documented.

Therefore, I would like to discuss more thoroughly the importance of managing the mainstream breeds by maintaining their future genetic diversity as part of breeding programmes.

## Present Status

The classic measure for genetic improvement per generation is accuracy (the square root of heritability,  $h$ ) times the genetic selection differential expressed in real units of the trait ( $i\sigma_g$ );  $\Delta = hi\sigma_g = h^2 i\sigma_p^2$ , in which  $h$  is the correlation between genotype  $g$  and phenotype  $p$ ,  $h^2$  is the regression of  $g$  on  $p$ ,  $i$  is the selection differential and  $\sigma_g$  and  $\sigma_p^2$  are genetic standard deviation and phenotypic variance, respectively. Efficient methods for registration of lineage and such traits as performance, fertility, health and survival for individuals in a population have been implemented. At the same time, efficient methods for breeding value estimation were developed, which linked the individual's traits to all relatives. These methods were based on the principle of “Best, Linear Unbiased Predictions” (BLUP), (Henderson, 1976).

Due to the before mentioned development, a limited number of certain individuals and their relatives can easily come to dominate as parents in future generations. As a result, the breed will eventually consist of animals originating from fewer and fewer families. As time passes, the average degree of relatedness between parents increases and thus, the inbreeding rate will increase.

## Developing a Sustainable Breeding Theory

An important discovery within genetic theory was the effect of selection on genetic variation. This was developed by Bulmer (1971) and shows that systematic selection of parents results in reduced genetic variation among their offspring. After four to five generations with the same selection intensity, the reduction will stabilise. In practical cattle breeding work, Fimland (1979) showed that this reduction could amount to 20 – 30%, depending on the selection intensity and accuracy. Systematically, intensive selection thus leads to the stabilisation of

genetic variation at about 70 - 80% of the level of variation achieved with random mating and no selection.

The next step towards developing a more realistic foundation for breeding work was the discovery of the dynamic traits of the additive kinship matrix **A**, by Hill (1974), Henderson (1976), Thompson (1977) and Wray and Thompson (1990). The elements in the **A** matrix generate covariance or degrees of relatedness between all individuals in a pedigree for the respective population, as well as the individuals' inbreeding status along the diagonal of **A**. When determining **A** from the "base" generation, one can identify gene transfers throughout all individuals in a lineage; sires to sires, sires to dams, dams to sires and dams to dams, from the base generation to the present population. In addition, one gets an overview of the individuals that have provided a lasting genetic contribution to genetic improvement, and of those individuals that no longer are considered as contributors to genetic improvement.

The latest major step of this development was the establishment of the unique "genetic contribution" theory put forward by Woolliams and Thompson (1994), which also provided a tool to estimate values for  $\Delta G$  and  $\Delta F$ . The two defined factors that determine genetic improvement and inbreeding rate are:

- A factor,  $r$ , which is the additive genetic contribution from an individual in a pedigree to today's population, where the corresponding element of **A** is a function of  $r$ . When  $r > 0$ , the individual is a contributor to genetic improvement, but when  $r = 0$ , the individual has not contributed to the genetic improvement of today's population. The sum of  $r$  of all dams contributing to the present population is 0.5. The same applies to the sires contributing to the present population.
- The breeding value of an individual is comprised of:  $g = \frac{1}{2} g_s + \frac{1}{2} g_d + s$  where  $g$ ,  $g_s$ ,  $g_d$  are the additive breeding values for the individual, sire and dam, respectively; and  $s$  is the individual's unique additive breeding value for the trait, consisting of the individual's unique gene combination in addition to the additive breeding value transferred by the parents. Variation of this element,  $s$ , can amount to more than half of the additive genetic variation of present populations. The expression is used because if selection is carried out in the parent generation, the additive genetic variation that is transferred from the parents to their offspring will be less

than when using random mating and no selection among parents (the so-called Bulmer effect). The value of  $s$  is often called the "individual's sampling term".

It was shown that:

1.  $\Delta G =$  sum of  $r$  multiplied by  $s$  for all individuals in the pedigree who pass on genes to individuals in today's population ( $\Delta G = \sum r \times s$ ). This shows that genetic improvement is a direct product function of the individuals contributing genes ( $r > 0$ ) and the corresponding value of  $s$ , which expresses the individual's unique gene combinations, i.e., the genes that are not additively passed down from the parents or from more distant relatives in the pedigree.
2.  $\Delta F =$  sum of  $r$  squared for all individuals who contribute genes to individuals in today's population ( $\Delta F = \frac{1}{4} \sum r^2$ ), under certain assumptions, e.g. random mating.

Due to the dynamics of breeding work, if one goes back five to seven generations in the pedigree, the contribution from those parents passing on genes to present-day and future individuals will be the same for each of these ancestors. This means that the genetic contribution of previous "matadors" (extensively used) breeding animals that have contributed to a large share of genes in today's population cannot be changed in a closed breeding population. In a closed population, genetic change will take place for those genes that can contribute to new gene combinations. Such new gene combinations can only occur via the "gene base", which is identified by the individual's sampling term. The individual's sampling term is the individual's specific and unique set of genes, and thus represents the foundation for future genetic renewal that can occur within closed populations. Fifty per cent of genetic variation is fixed through previous selection of parents and earlier relatives. Only in the most recent generations will genetic contributions be affected by the accuracy of the breeding value and the individual's selective benefit. It is thus obvious that an individual contributing to sustainable improvement has a sampling term that is larger than the average of its parents' breeding value. The characterisation of this genetic diversity shows a resource potential for the respective trait and population. Theoretically, an individual's sampling term as an infinite resource will only exist for traits consisting of an infinite number of *loci*. For traits with only one *locus* or few *loci*, selection will rapidly approach fixation, and thus be depleted of its genetic variation.

In closed populations with intensive selection and the use of few sires, the long-term contribution and a large share of the genes will be provided by only a few individuals. In such cases, the effective population size, which is  $N_e = 1/(2\Delta F)$ , will be relatively small. Since the selection space for breeding work is  $2N_e i h^2 \sigma_p^2$ , breeding programmes with small effective population sizes ( $N_e$ ) will result in less total improvement than breeding programmes that secure larger effective population sizes. It has been indicated that moderate selection (about 50%), especially in the first generations, will ensure maximum genetic improvement in the long run. It should be well known that intensive selection in the start-up phase of a breeding programme leads to the loss of numerous beneficial genes in the first few generations, due to the effect of linkages between *loci*. A more moderate selection intensity early in the programme will help to 'break apart' these linkages as time progresses, thus enabling more beneficial genes to be passed on to future generations, (Alan Robertson personal communication from 1974).

One way to regenerate genetic variation is to enable immigration of genes from various other populations. This is the most effective way to provide new genetic variation, especially when the external population contains more beneficial genes than the mother population. However, immigration from other, similar populations can also lead to improved genetic variation, especially for inbred mother populations. For these, genetic variance would be  $(1-F)\sigma_g^2$ , where  $F$  is accumulated inbreeding. In such cases, the new supply of genes can "break apart gene pairs identical by descent" that have been inherited from the same ancestor and replace these with genes that are either more beneficial or have the same functional value. In either case, inbreeding will be discontinued, thus revitalising the genetic variation within the population.

Optimised selection is the maximisation of the selection differential, with the restriction that  $\Delta F$  is less than, e.g. 0.5%, in which case  $N_e = 100$  animals. Optimisation is achieved by maximising the selection differential for the potential parents by using a mating strategy that keeps the inbreeding rate in the next generation below a given value, e.g. 0.5%. The process of optimisation implies determining which animals to use in breeding, and deciding on the relative genetic contribution of each of these,  $c_i$ . This includes, for example, determining the relative share of semen provided by each proven

sire. If this value is expressed as  $c_i$ , optimised selection will result in maximised correlation between  $c$  (contribution to next generation) and  $r$  (long-term contribution).

## Effect of Selection

In classic breeding, genetic improvement is accuracy ( $h$ ) times selection intensity ( $i$ ) times genetic standard deviation for the trait. Note that the term "accuracy" here is an expression relating to the accuracy of an individual's breeding value ( $g$ ). Due to uncertainty and other factors, certain selected individuals may not contribute to future genetic gains. For example, it has been shown that some bulls selected as breeding sires generate progeny which for various reasons do not contribute to genetic improvement.

By calculating the contribution to genetic gain ( $\Delta G = \Sigma r \times s$ ), where  $r$  is the long-term contribution, and  $s$  is the sampling term, one sees that these bulls (with  $r = 0$ ) do not contribute to genetic improvement.

This implies that:

1. Long-term contribution ( $r$ ) correlates better with the breeding value of the individual's sampling term ( $s$ ) than with the individual's breeding value ( $g$ ). In other words, the individual's selectivity is more closely tied to the value of the sampling term ( $s$ ) than to the individual's breeding value ( $g$ ).
2. Additive genetic variation from  $g_i$  is less than half of the variation of  $s$  - the individual's sampling term in populations under selection.
3. Due to restrictions on  $\Delta F$ , optimised selection leads to greater accuracy with regard to the contribution to genetic gain than when applying classic breeding theory, in other words, this maximises the correlation between  $c$  (contribution to next generation) and  $r$  (long-term contribution).
4. Optimal selection secures "new genes" with selective benefits from potential parents' sampling term,  $s$ , and which have not been previously expressed by animals in the pedigree. Such animals will contribute to sustainable breeding gain in future generations.

An analysis done by Avendano *et al.* (2004) shows the following results:

1. Correlation squared between the long-term contribution ( $r$ ) and estimated sampling term ( $s$ ) is 0.84
2. Correlation squared between the long-term contribution ( $r$ ) and estimated breeding value ( $g$ ) is 0.43

This means that restricted inbreeding in breeding programs improves the efficiency of breeding operations.

It was also shown that the effect of selection in an optimised selection strategy was 0.92, compared to 0.50 in ordinary BLUP selection, i.e., nearly twice as much. Furthermore, optimal selection gave 20% more genetic improvement than ordinary selection. These results confirm that, when selecting parents, restrictions on expected  $\Delta F$  in the next generation reflect the individual's sampling term,  $s$ , rather than the breeding values of the individual's parents.

Several analyses have shown that restrictions on the rate of inbreeding can lead to the apparent loss of phenotypic selection differential. Restriction of inbreeding in the optimal selection scheme leads to the selection of alternative parent animals with a higher probability of contributing to the renewal of genetic variation. It is also more probable that these breeding animals will contribute to the long-term genetic gain ( $r > 0$ ) than animals selected for ensuring a maximum 'phenotypic' selection differential. When placing restrictions on inbreeding rates for the next generation, the net effect is that the product of selection differential times accuracy is maximised. This implies that optimal selection in general includes the use of breeding animals that lead to greater selective benefits and higher probability for a long-term contribution to genetic gain. The result is more efficient genetic improvement than when selection is merely based on BLUP values.

## Conclusions

Optimal selection focuses on:

1. The individual's selectivity, which is dependent on the relative share of genes ( $r$ ) and a positive additive value of the individual's sampling term ( $s > 0$ ).
2. Maximising the probability that the selection of parents gives unique, new genes that contribute to genetic improvement in coming generations, i.e. finding potential parents with a considerable probability of providing unique and new genes from their sampling term.

3. Genetic improvement requires that, new, unique and beneficial genes be introduced from the sampling term of each new generation of potential parents.
4. Selection for traits with limited number of *loci* will gradually reduce the genetic variance as *loci* become fixed. In traits with infinite number of *loci* the random sampling term with its genetic variance seem to be unaffected by selection. However the intense selection of the parent implies that the parent's contribution to the next generation of the genetic variance will be less than  $\frac{1}{2}$ . Thus, the sum of the random sampling term of genetic variance and the part coming from the parent will be less than the original genetic variance with no directional selection of the parents, i.e. the Bulmer-effects.
5. The only practical way to break long time inbreeding is to immigrate genes from other breeding population. Such refreshing of blood to local breeds has been done in many breeds during the history. The question of where to find a breed that can be accepted for use, may become a question of life or death for some populations.

## List of References

- Avendano, S., J.A. Woolliams & B. Villanueva.** 2004. Mendelian sampling terms as a selective advantage in optimum breeding schemes with restrictions on the rate of inbreeding. *Genet. Res., Camb.* 83, 55-64.
- Bulmer, M.G.** 1971. The effect of selection on genetic variability. *The American Naturalist* 105, 201-211.
- Chesnais, W. Fairfull, J. P. Gibson, B.W. Kennedy & E.B. Burnside.** 1994. Proceedings of the 5th World Congress on Genetics Applied to Livestock Production, Guelph, Ontario, pp. 127-134.
- Cunningham, E.P. (Ed.).** 2003. After BSE – A Future for the European Livestock Sector. EAAP publication no. 108.
- Drucker, A.G.** 2001. The Economic Valuation of AnGR: Importance, Application and Practice. In: Proceedings of the workshop held in Mbabane, Swaziland, 7-11 May 2001.
- Fimland, E.** 1979. *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 96, 120-134

.....

**Henderson, C.R.** 1976. A simple method for computing the inverse of a numerator matrix used in prediction of breeding values. *Biometrics* 32, 69-84.

**Heringstad, B., R. Rekaya, D. Gianola, G. Klemetsdal & K.A. Weigel.** 2003. Genetic change for clinical mastitis in norwegian cattle: a threshold model analysis. *J. Dairy Sci.* 86: 369-375.

**Hill, W.G.** 1974. Prediction and evaluation of response to selection with overlapping generations. *Animal Production* 18:117-139.

**Simm, B. Villanueva, K.D. Sinclair & S. Townsend (Eds).** 2004. *Farm Animal Genetic Resources.*, BSAS Publication No. 30. Nottingham University Press, Nottingham NG11, 0AX. ISBN 1-897676-15-8, SB, pp. 345.

**Thompson, R.** 1977. The estimation of heritability with unbalanced data: ii. data available on more than two generations. *Biometrics*, Vol. 33, no. 3, pp. 497-504.

**Woolliams, J.A. & Thompson R.** 1994. In: *Proceedings of the 5th World Congress on Genetics applied to Livestock Production*, Guekph, vol. 19.

**Woolliams, J.A.** 2006. Sustainable Livestock Breeding – Food Security and Safety. “Nordic GENEResources”, ISBN 92-893-1153-3, [www.nordgen.org/publikasjoner/nordiskegenressurser.htm](http://www.nordgen.org/publikasjoner/nordiskegenressurser.htm)

**Woolliams, J., P. Berg, A. Maki-Tanila, T. Meuwissen, E. Fimland.** 2005. Sustainable Management of Animal Genetic Resources- As: Nordic Gene Bank Farm Animals. ISBN 92-893-1089-8, pp. 95.

**Wray, N.R. & Thompson R.** 1990 Prediction of rates of inbreeding in selected populations. *Genet. Res.* 55, 41-54.

# Integrating policies for the management of animal genetic resources with demand for livestock products and environmental sustainability<sup>1</sup>

*H.D. Blackburn*

*National Animal Germplasm Program, National Center for Genetic Resources Preservation, ARS, USDA, Fort Collins, CO 80521, USA,*

## Summary

Global recognition of the need to conserve animal genetic resources comes at a time when the livestock sector faces significant challenges in meeting the growing demand for livestock products and the mitigation of negative environmental impacts caused by livestock. In developing regions it would seem that portions of the growing demand for livestock products are being met by increasing animal numbers instead of achieving increases in production efficiency. Concurrently, extensive grazing and mixed crop-livestock production systems are largely responsible for significant greenhouse gas emissions and other forms of environmental degradation. Under the growing demand and environmental sustainability rubric there exists a need to garner maximum benefit from diverse animal genetic resources. These three areas; growing demand on animal products, environmental issues, and conservation of AnGR form a nexus that national policies must simultaneously consider. To advance this integration, a policy framework is proposed that consists of incentives to produce, a secure resource base (e.g., genetic resources, land tenure) and access to markets for outputs and inputs including technology. Within this framework a set of potential policies are suggested that promote conservation, livestock sector growth and environmental sustainability.

## Résumé

La reconnaissance au niveau mondial du besoin de conserver les ressources génétiques animales arrive à un moment où le secteur de l'élevage se trouve à faire face à des défis importants tels que l'augmentation de la demande de produits et

comment atténuer l'impact négatif sur le milieu du à l'élevage. Dans les régions développées il semblerait qu'une partie de l'augmentation de la demande de produits puisse être obtenue avec l'augmentation du nombre d'animaux au lieu d'essayer d'augmenter l'efficacité de la production. Au contraire, le pâturage extensif et les systèmes mixtes de production agriculture-élevage sont en grande partie responsables des émissions de gaz de serre et d'autres formes de dégradation du milieu. Si nous considérons les normes au sujet de l'augmentation de la demande et la durabilité de l'environnement il faudra obtenir un bénéfice maximum des différentes ressources génétiques animales. Les trois domaines sont:

1. L'augmentation de la demande de produits d'origine animale.
2. Les problèmes de l'environnement.
3. La conservation des formes de AnGR comme point d'union pour les politiques nationales.

Pour atteindre cette intégration il est nécessaire de créer un cadre politique qui prévoit des primes à la production, une ressource de base fiable (p.e. ressources génétique, propriété de la terre) et un accès aux marchés pour les produits et la technologie. Dans ce cadre on suggère d'inclure un ensemble de normes potentielles pour promouvoir la conservation, la croissance du secteur élevage et la durabilité du milieu.

## Resumen

El reconocimiento mundial sobre la necesidad de conservar los recursos zoogenéticos llega en un momento en que el sector ganadero se enfrenta a

---

<sup>1</sup>Mention of a trade name, proprietary product, or specified equipment does not constitute a guarantee or warranty by the USDA and does not imply approval to the exclusion of other products that may be suitable.

desafíos importantes como el incremento de la demanda de productos ganaderos y cómo atenuar los impactos negativos sobre el ambiente debidos a la ganadería. En las regiones desarrolladas podría parecer que una parte del aumento de la demanda de productos se podría conseguir con el incremento del número de animales en vez de intentar aumentar la eficacia de producción. Al revés, el pastoreo extensivo y los sistemas mixtos de producción agricultura-ganadería son en gran parte responsables de las emisiones de gas y otras formas de degradación ambiental. Bajo las normas de incremento de la demanda y sostenibilidad ambiental existe la necesidad de conseguir un beneficio máximo de los distintos recursos zogenéticos. Estas tres áreas son:

1. Incremento de la demanda de productos animales.
2. Problemas ambientales.
3. Conservación de formas de AnGR como nexo para las políticas nacionales.

Para alcanzar esta integración es necesario un marco político que consiste en incentivos a la producción, un recurso de base seguro (p.e. recursos genéticos, propiedad del terreno) y un acceso a los mercados para los productos y la tecnología. Dentro de este marco se sugiere incluir un conjunto de políticas potenciales que promuevan la conservación, el crecimiento del sector ganadero y la sostenibilidad ambiental.

**Keywords:** *Awareness, Industrial production systems, Meat consumption, Environmental Issues, AnGR use, Consumer demand, Climate change, Access to markets.*

## Introduction

During the past decade awareness concerning the contraction of animal genetic resources (AnGR) has increased, particularly through the reporting process of FAO's State of the World's Animal Genetic Resources (SOW; FAO, 2007). The SOW report highlights issues confronting the use and conservation of diverse animal genetic resources. It suggests that the major challenges for countries are to balance different livestock policy objectives that maintain animal genetic resource diversity, environmental integrity, increasing demand for livestock products, and contributions to rural development and poverty reduction. Given that AnGR are a component of the livestock sector, measures taken to conserve genetic resources should complement other initiatives designed to advance the sector. Nesting AnGR within livestock

development is necessary due to the environmental and economic development pressures that are currently placed on livestock industries, especially in the developing world. Principally, to meet the growing demand for livestock products, animal productivity needs to be increased and the environmental foot-print contained.

Two important driving forces are the unprecedented growth in demand for livestock products (Delgado *et al.*, 1999) and global environmental issues (de Haan *et al.*, 1997; Steinfeld *et al.*, 2006). Increasing demand for livestock products has spurred acceleration in industrial production systems and significant growth in poultry and swine production (Steinfeld *et al.*, 2006). In turn, such increases have or are having significant environmental impacts. In addition, the move to more intense industrial types of production systems coupled with increases in selection intensity contribute to the loss of animal genetic resources within those production systems.

The goal of this paper is to explore the major forces - product demand, environment and productivity - that impact AnGR and the type of policies that facilitate the integration of AnGR conservation, economic growth, and environmental issues. The paper approaches this by presenting an overview of the demand for livestock products, major environmental issues confronting the livestock sector, and how animal genetic resource use may change in relation to these forces. Given this discussion, a policy framework capable of addressing these three issues is presented and followed by several policy options that integrate the issues of demand, environment, and conservation.

## Demand for Livestock Products and Growth of the Livestock Sector

Delgado *et al.* (1999) have estimated that total meat consumption in the developing world will increase from 88 000 000 metric tons in 1993 to 188 000 000 metric tons in 2020, a 4.2% per year increase. Such an increase in demand suggests that to keep pace with livestock product demand, per animal productivity will have to increase, production systems will have to intensify, and commercially viable genetic resources will have to be utilized more extensively (whether they are indigenous, exotic, or were developed for industrial production system use). In many production systems indigenous AnGR have been used to play



fundamental subsistence and sustainability roles in extensive and crop-livestock systems (Rege and Gibson, 2003). However, this position is and will continue to be challenged, potentially resulting in a further contraction or loss of genetic resources. Table 1 shows that the rate of increase in livestock production is not consistent across regions but progress is being made toward meeting the projected demands estimated by Delgado *et al.* (1999). Table 1 also shows the increasing importance of monogastric species, in agreement with SOW (FAO, 2007) and Steinfeld *et al.* (2006). However, when increased production is converted to per head productivity for cattle, milk, and small ruminants (Figure 1) it is apparent that not all regions are experiencing an increase, and most notably contributions from small ruminants and beef cattle are lagging in some developing regions. It is acknowledged that significant increases in monogastric species has occurred, but such information was not available in the dataset. FAO (2007) illustrates that producers respond to increasing demand by expanding herd size, diversification of production or processing, intensification of existing production patterns and increasing the proportion of off-farm income. It would appear from table 1 and figure 1 that producers are responding to demand signals primarily by increasing herd size, with some diversification of production and processing, and/or intensification of specific production systems (FAO, 2007; Steinfeld *et al.*, 2006).

## Environmental Issues – A Global Concern

During the past 35 years the livestock sector has continually been placed in an adversarial position due to real or perceived negative impacts on the environment. Environmental issues have been and will continue to be a point of contention for

livestock industries and how societies choose to utilize livestock species (de Haan *et al.*, 1997; Steinfeld *et al.*, 2006). Furthermore, the impacts livestock are having on the environment are occurring across all livestock production systems (extensive grazing, mixed farming, and industrial), species, and geographic regions. The breadth of this issue is dramatic and concerning, especially with regard to the livestock sector's need to meet further consumer demands. On a global scale, livestock impact the environment by overgrazing, climate change (soil organic matter oxidation and carbon release into the atmosphere), water resources depletion (through reduced recharge of ground water), and biodiversity loss via habitat destruction (Steinfeld *et al.* 2006; de Haan *et al.* 1997). Of particular concern, as Steinfeld *et al.* (2006) illustrated, is the total greenhouse gas emissions from enteric fermentation and manure that are greatest in Latin America, Sub-Saharan Africa, China, and South and East Asia (Figure 2). The species emitting the largest amounts of gases are cattle and buffalo produced in extensive grazing and mixed crop-livestock production systems. This result is surprising, as it was often assumed that mixed crop-livestock and extensive grazing systems were relatively benign contributors to greenhouse gas emissions compared to industrial systems. This finding has important ramifications because located in these production systems and geographic areas are significant portions of AnGR. As a result steps to mitigate environmental impacts will also impact these AnGR. While such results are of concern and warrant action, potential solutions to mitigate greenhouse gas emissions do exist. For example, Leng (1991) illustrated that improving ruminant diet quality, particularly in the mixed crop-livestock systems, can reduce greenhouse gas emissions.

In addition to greenhouse gas emissions, landscape degradation by grazing ruminants remains an important issue in Africa, Central and South Asia, and Central and South America. As a result of such pressures, Asner *et al.* (2004) suggest

Table 1. Annual percent change in production from 1994 to 2004 across developing regions.

Region/Product	Small				
	Beef	ruminant	Pork	Eggs	Milk
Sub-Saharan Africa	2.8	4.1	2.0	2.1	3.1
Asia	18.8	6.7	4.9	7.7	4.5
Central – South America	4.3	-0.5	5.8	2.7	3.7
West Asia – North Africa	1.8	1.1	4.5	3.0	4.5

Data source: H. Steinfeld, unpublished.

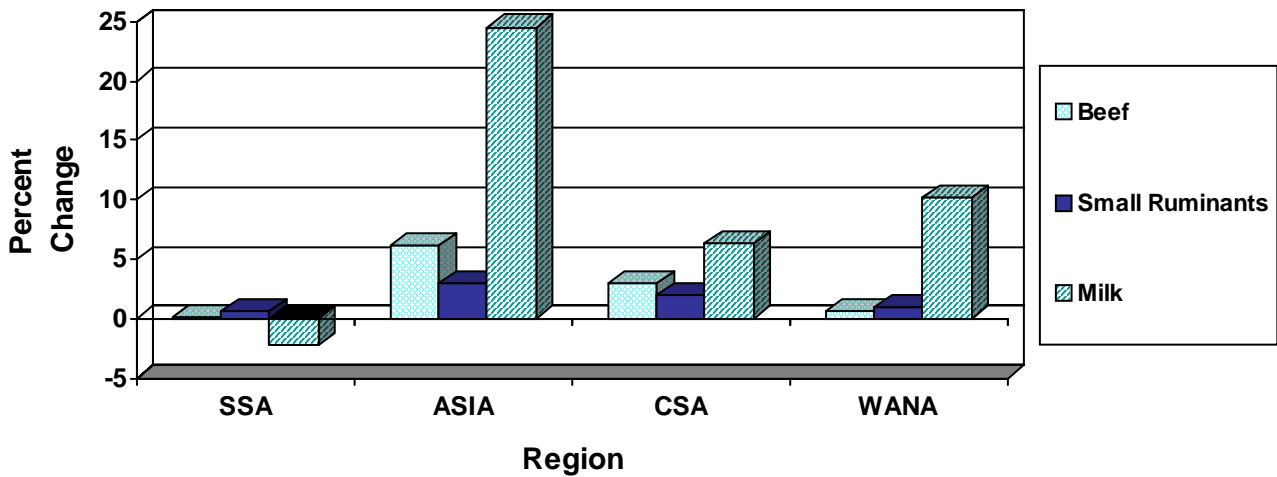


Figure 1. Annual percent change in production per head from 1994 to 2004 for Sub-Saharan Africa (SSA), Asia, Central and South America (CSA), West Asia and North Africa (WANA).

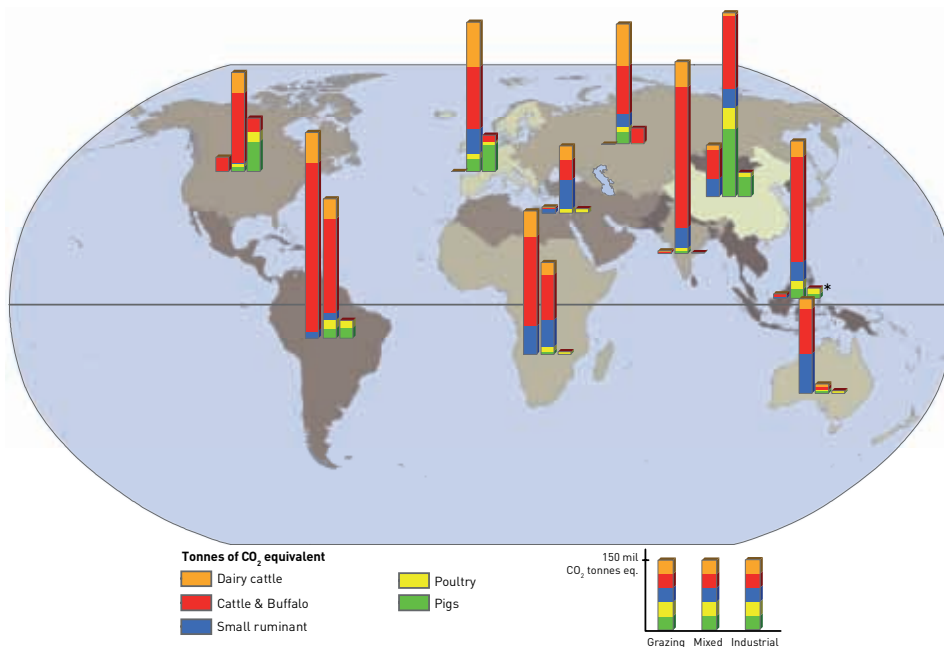


Figure 2. Total greenhouse gas emissions from enteric fermentation and manure per species and main production system. (Source: Steinfeld et al., 2006).

three types of ecosystem degradation occur these being desertification in arid areas, increased woody plant cover in semi-arid/subtropical rangelands and deforestation in humid climates. Technical capacities exist to resolve the grazing livestock issue; however, the social and political implications of such solutions often impede implementation. For example, it is well known that successful utilization of arid grazing areas is dependent upon the ability to adjust animal numbers to climatic conditions and the ability to migrate from areas experiencing drought. Yet, producers find it difficult to destock at appropriate times, and movement to areas less

impacted by drought are difficult when dry season grazing areas are converted to crop agriculture and government policies restrict livestock movement.

Despite the array of negative environmental issues interfacing the livestock sector it is important to recognize that there are significant positive impacts which livestock have on the environment. Many examples have demonstrated how livestock can reduce chemical dependence for vegetation management - for example, in rubber production in South East Asia (Ismali and Thai, 1990) and in controlling noxious weed infestation in North America (de Haan *et al.*, 1997). In equilibrium

grazing systems no difference in erosion or water infiltration between light and moderately and ungrazed areas has been shown to exist (Blackburn *et al.*, 1982). Appropriately managed industrial systems can result in lower methane production (FAO, 2007) via increased efficiency, and concentration of livestock can lead to more cost effective mitigation of livestock pollutants (de Hann *et al.*, 1997). These types of positive livestock-environment interactions should be capitalized upon when policies for the sector are being designed.

## Changing Animal Genetic Resource Use

As a result of changes in livestock product demand and environmental pressures, there is a need to better assess breed performance and explore altering breed performance levels within and across production systems to meet the challenges previously discussed. Such an evaluation should be focused on the judicious use of AnGR. Threats to AnGR have been summarized and include changes in production systems, markets preferences and environments, natural catastrophes, genetic dilution due to exotic germplasm use, unstable policies from public and private sectors and limited funds for conservation activities (Rege and Gibson, 2003; FAO, 2007). A number of policy interventions have been suggested to alleviate these situations; however, these policy recommendations have not been implemented, for as Mendelsohn (2003) states “*the conservation community has not provided a clear statement of the benefits of conserving AnGR*”. By including AnGR in national agricultural policies, an integration of AnGR conservation and livestock sector development can be forged. Such a balance would ensure that an array of genetic variation is available for future utilization while enabling the advancement of other livestock production strategies.

With the dynamics of a livestock revolution upon us, it is useful to explore how AnGR use could change and therefore what policies might need to be developed. An important element of the livestock revolution is that economic growth and income levels will increase. As incomes grow there is a high income elasticity of demand for meat and other livestock products (Delgado *et al.*, 1999). It is the combination of income growth and elasticity of demand that enables broader sections of the global

society to increase their consumption of livestock products.

## Changing consumer demand

There are examples of how consumer affluence and awareness impacts AnGR use. Several European countries have established landscape management programs that either require or suggest that rare/minor breeds be utilized. Participation in such programs by breeders provides an opportunity to obtain additional revenues, offsetting the difference in production income. However, care must be taken with such programs to ensure they do not to foster unnecessary subsidies or impediments to trade. There is anecdotal evidence suggesting that consumer demand will eventually shift toward a more diverse set of genetic resources. Such a pattern has been reported for heritage turkey breeds in the US (Blackburn, 2006) and rare breeds of sheep in Brazil (Mariane, personal communication). This demand tends to be coupled with an interest in supporting local products and the utilization of livestock for landscape management. Consumption of local products tends to be limited by the consumers’ perception of price and that these products are for use on special occasions (Amanor-Boadu, personal communication). Furthermore, such changes have only emerged during the last decade and the scope and depth of these markets are unclear. However, these trends suggest that having a broad array of genetic resources available for future use to meet consumer demands will be of benefit to livestock keepers. Figure 3 presents a conceptualization of this scenario where consumer utilization of genetic diversity goes through a bottleneck and then broadens out as income levels increase and consumer preferences change. In essence, market demands will slow and/or mitigate contractions in genetic diversity and potentially broaden the use of AnGR as incomes increase and cause a shift in consumer preferences. If such a scenario were to become more prevalent, the challenge would be one of positioning national livestock populations to capitalize on the situation. Steinfeld *et al.* (2006) has suggested that globally there is still going to be a decrease in animal genetic diversity. However, they do point out that with consumers demanding more livestock products those same consumers will be more interested in knowing and determining how their livestock products are produced which would support the concept of a shift in genetic resource use that is illustrated in figure 3.

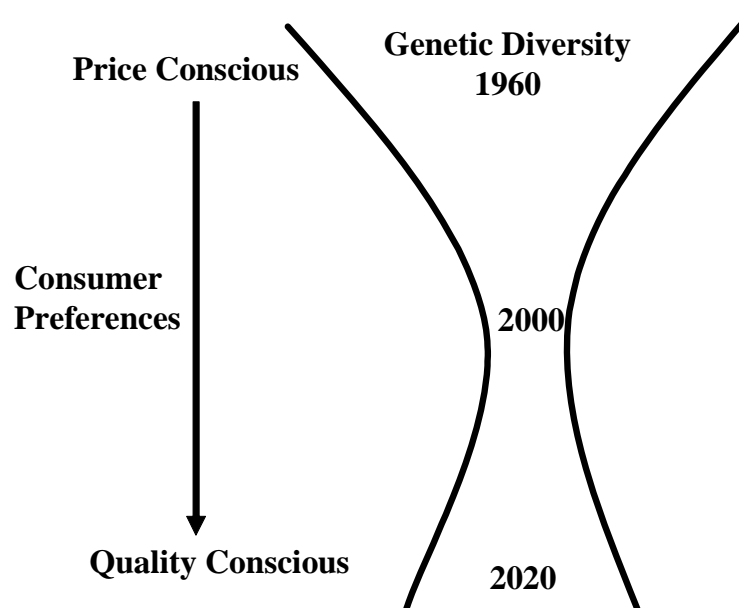


Figure 3. Potential utilization of genetic diversity as income levels and consumer preferences change.

## Climate change

Global climate change is a potential driver for altering how AnGR may be used. If there is significant climate change it will most likely have the largest impact on ruminant species produced in extensive grazing systems, as those species and production systems are already subjected to relatively large environmental variations. Hanson *et al.* (1993) simulated an extensive grazing system in a short grass prairie under global climate change conditions of altered temperature, precipitation and increased CO<sub>2</sub> levels in northeastern Colorado (USA). Under all scenarios plant production increased but forage quality decreased. As a result weaning weights, cow weights and average daily gain decreased slightly. More importantly, variances for plant parameters increased suggesting that carrying capacities should be lowered by 36% to maintain a 90% confidence of not overstocking this rangeland. The potential for increased frequency of drought has also been discussed as a potential result of climate change, particularly for the African continent (FAO, 2007). Blackburn and Cartwright (1987) explored the impact of drought on varying genotypes and found that when genotypes are out of balance with the production system, a herd or flock's ability to recover from drought is compromised. Blackburn *et al.* (1990) extended this analysis and showed that smallholders are at greatest risk during such events and have less of a chance of recovering. Under such challenges balancing genotypes with production

systems will become a crucial element requiring the utilization of diverse genetic resources with appropriate genetic potentials for growth, milk production, resistance to disease and prolificacy.

Altering breed types is also an alternative response to climate change. Cundiff (2005) suggested a range of near optimal combinations of *Bos taurus* and *Bos indicus* inheritance as geographic locations changes within the USA (Gulf Coast, southern states and temperate regions). This situation can be observed in other countries having similar ranges of environments and genotypes that produce products for different markets (internal consumption, exportation to different and varied markets having specific demands in quality). For all such production systems, potential climate change could alter the suggested *Bos taurus* and *Bos indicus* combinations, resulting in new opportunities for AnGR use. Souza *et al.* (1998) underscored this point by demonstrating the presence of genetic-environmental interactions and subsequent changes in ranking across regions with Nellore cattle in Brazil. Under conditions of climate change such differences may be magnified. Madalena *et al.* (2002) discussed how poultry housing lacks environmental control in southern Asia, and therefore the need for local chicken breeds or varieties for industrial systems. The present use of such genotypes would suggest they would have greater importance under a global warming scenario. Kolmodin *et al.* (2002) showed how selection in the presence of genetic-environmental interaction may increase animals' environmental

sensitivity. They also implied that animals could be selected for low sensitivity which could be an advantage in low input systems, or in the event of climate change. The work done by Misztal and Ravagnolo (2002) demonstrated how selection in Holsteins for heat resistance can be accomplished. All these reports suggest the reality of genetic-environmental interactions and the need to have genotypes that match the production environment in the event of a potential change in climate. Reports have also shown that selection for adaptability is possible; however, indigenous genotypes may already have a comparative advantage in the context of climate change, suggesting a need for within breed selection.

### Genetic improvement

Genetic improvement activities in developing countries have had a checkered history (Madalena *et al.*, 2002). In part, genetic improvement among indigenous breeds for commercial traits is difficult due to the time required to achieve predetermined selection goals and therefore crossbreeding or breed substitution have been viewed as more expedient methods of increasing animal productivity. However, numerous reports detail the failure of various crossbreeding and breed substitution projects. Further complicating within breed improvement in developing environments is that single trait selection is not appropriate, and, when applied, genotypes may become unbalanced during periods of environmental instability (Blackburn and Cartwright, 1987). However, if multiple trait selection goals are clearly defined it may be possible to keep genetic combinations in balance during the selection process. This concept was simulated for pastoral sheep production in northern Kenya (Blackburn and Taylor, 1990), where selection for increased mature size and milk production was evaluated. These results indicated that culling age, which directly impacts selection intensity and genetic gain, was important in maintaining flock productivity. As culling age increased, flock productivity was higher than when culling age was decreased, resulting in a shorter generation interval. The need to retain animals longer to maintain production levels (which impacts generation interval) implies higher intensities of selection and therefore the need to closely monitor inbreeding levels.

Recent work by Gollin (personnel communication) suggests that indigenous genotypes (or those present in the production

system for considerable time) may have a commanding advantage in terms of productivity and that there will not be significant migration of genetic resources from developing to developed countries. He found that under prevailing market conditions and existing levels of productivity with the current set of breeds, that imported breeds from developing countries have little opportunity to become mainstreamed, making successful new breed importation difficult to achieve. This result draws into question the hypothesis of Gibson and Pullin (2005) that there would be increased demand for genotypes from developing countries.

## General Agriculture Policy Goals

National agricultural policies are developed principally to promote economic growth and food security. In setting national policies there is an international consensus that direct government interventions in the economy generally should be reduced along with fiscal expenditures (Norton, 2004). Norton further explains that at the producer level, agricultural policies should fulfill three basic needs: incentives to produce (not to be confused with subsidized production), a secure resource base, and access to markets for outputs and inputs, including technology.

AnGR conservation management intersects these three basic needs and therefore policies concerning AnGR can be structured within each of the three areas. However, complicating the development of AnGR policies is the lack of assessment and valuation methodology for AnGR in the context of food security and economic growth. Clearly, AnGR can contribute to economic growth and food security, but the level of contribution has not been quantified in any substantial way, underscoring Mendelsohn's (2003) view. In general, we do know that the livestock species domesticated by man in the last 12 000 years contribute directly or indirectly to 30 to 40% of the total value of food or agriculture production at a global level (FAO, 2000). But such assessments at the breed level are missing.

## Policy Framework for Animal Genetic Resources

Potential policies range from broad to specific policy instruments that are targeted directly at

AnGR, livestock-environmental interactions, and livestock sector development. The framework discussed strives to promote all three elements through the areas of incentives to produce, a secure resource base, and access to markets for outputs and inputs. Madalena *et al.* (2002) stated the major issues depressing effective breeding and AnGR utilization are excessive bureaucratic constraints and the need for producer driven programs. They also suggest that breeding programs are not likely to “succeed if the program is focused upon grandiose schemes, are run by government or international agencies, or are driven by policy goals with few benefits to participants”. In other words, breeding and AnGR utilization are private sector activities where government, international agencies and non-governmental organizations should play secondary or supportive roles. This perspective confirms the points made by Norton (2004).

Given the issues of AnGR addressed by Madalena *et al.* (2002) and the fact that AnGR are contracting, there is a need for policies to manage AnGR that consider the performance of past efforts and the realities of the challenges in meeting the demands of the livestock revolution. Given the practical considerations of Madalena *et al.* (2002), effective policy formulation is also inhibited by the need for determining the long term value of AnGR (Mendelsohn, 2003). Gollin and Evenson (2003) point out three primary sources of value - direct use, indirect use, and non-use - which can serve as approaches to establish the quantitative worth of AnGR. Studies articulating the value of AnGR using one of these three valuation approaches are necessary to firmly establish effective long-term policies. It is key in developing methods for valuing AnGR that not only market value but other traits like adaptation to local environment or disease resistance, which in fact also determine the value of the resource be considered (de Haan *et al.* 1997; Rege and Gibson, 2003). Kanis *et al.* (2005) proposed a method based on selection index theory which incorporates socially important traits such as animal welfare and health, which can be selection goals but have no direct economic value. Such an approach could be applied on a community basis where genetic resources must be well matched to the production environment because AnGR are used as a food source, for traction, and/or manure. For these situations, the establishment of programs of participatory breeding with the owners or stakeholders of the AnGR is appropriate and must be factored into policy making for managing and conserving AnGR in conjunction with environmental and economic issues.

## Incentives to Produce

In many production systems producers have or are moving away from indigenous or minor breeds to take advantage of specific production traits (SOW, 2006). However, globally this type of breed substitution has been shown to be problematic, particularly among the ruminant species which are expected to produce in a new environment with little or no genetic or managerial modification. In most situations the new breed may be shown to be superior for a trait of interest (e.g., milk production, growth rate, disease resistance), but when evaluated on the basis of biological efficiency or life time productivity, the new breed often ranks below the breed already being utilized (Blackburn, 1995; Blackburn *et al.*, 1998). The mixed history of breed introductions suggests that prior to wide spread dissemination, multi-year breed comparisons be performed to better ascertain a breed’s potential in the new production system (de Haan *et al.*, 1997). Having such an analysis will make more evident the managerial changes necessary for some breed types to be effectively used and can be extended into cost/benefit analyses. The result of this effort should improve the decision making by breeders contemplating the use of new breed types and could encourage them to employ appropriate selection strategies.

In certain situations policies could be developed that encourage utilization of some breeds in conjunction with land conservation strategies. Such policies have been implemented in several European countries (FAO, 2007). There are additional opportunities to merge AnGR conservation efforts with landscape or vegetative management strategies. In such situations policies could specifically call for the utilization of rare and/or minor breeds. Furthermore, where vegetation is being controlled on public lands, access could be restricted to the use of rare and/or minor breeds. Such an approach would accomplish the land management goal and AnGR conservation without a cash subsidy but may create concern about producer equity. Where private lands are concerned the issue of payment has to be addressed and whether society deems such an effort important enough to make a public investment without distorting markets. Presently, it would appear that once a country’s economy reaches a sufficient level and consumer preferences change, as illustrated in figure 3, policies permitting direct subsidy payments may no longer be necessary. Perhaps the major issue with such strategies is whether or not sufficient scale in land mass and animal numbers

can be achieved to promote *in-situ/in-vivo* conservation of a large number of breeds. Some regions have implemented subsidies for maintaining breeds of interest based upon animal numbers (FAO, 2007) however, it would appear that such approaches invite producers to maintain numbers below minimum threshold levels to continue to receive the subsidy and therefore limit the growth and utilization of a breed.

## A Secure Genetic Resource Base

From a policy and technical standpoint the first and most significant step in securing AnGR is the development and implementation of a national database/information system. The development of this capacity enables policy makers, scientists, and industry to understand the country's AnGR through trend analysis of population demographics, geographic location, phenotypic and genotypic information, and ownership patterns. It also serves to document the utilization of various breeds. In addition, development of national databases is the first step in developing an understanding of the status of breeds that are shared between countries within a region.

The second policy step to secure the AnGR base is the country's decision to develop *ex-situ/in-vivo*, or *ex-situ*/cryopreserved collections of germplasm and/or tissue. The decision for *ex-situ/in-vivo* collections, *ex-situ*/cryopreserved collections or both is primarily a financial consideration (Gollin and Evenson, 2003) to the extent that the two are substitutes. It would appear that limited financial and physical resources will control the number of *ex-situ/in-vivo* populations that can be maintained and therefore *ex-situ*/cryopreserved collections will, in the long run, be a more flexible, cost effective, and sustainable approach for conserving AnGR. Such collections can serve multiple functions, for example: a secure reserve of germplasm for population regeneration; a source of genes that may potentially become lost due to selection pressure; a source of genes that assists breeders in modifying their populations to better meet consumer demand; and, a source of DNA for the research community. By increasing the scope of collection utilization the costs of collection development and maintenance are reduced. Furthermore, re-sampling can be performed to ensure that collections represent the populations at any point in time. Issues of collection redundancy can be addressed within a country, regionally or even on a global scale (although this is logistically more complex). On the other hand,

when funds are not limited, maintaining *ex-situ/in-vivo* populations have the advantage that populations can adapt to changing environments, production systems or markets. In addition, the population can be seen by farmers which in turn could facilitate actions to promote breed utilization.

## Access to Markets for Outputs and Inputs, including Technology

In order to facilitate national livestock sector economic growth potentials, and therefore allow countries to participate in the livestock revolution (Delgado *et al.*, 1999), rare and minor breed types will be under continued economic pressure (Mendelsohn, 2003; FAO, 2007). However, their position can be enhanced by eliminating the sources of market failure which Wollny (2003) cites as one reason for diversity loss. The positive benefits of establishing dynamic and well functioning markets, and their role in conservation and development, has been documented in the well studied Machakos District in Kenya. In this area market access made small scale dairying possible which in turn generated capital for investments in soil and water conservation (Tiffen *et al.*, 1994).

Some authors have suggested trade restrictions be put in place to reduce or eliminate the importation of exotic germplasm. However, as Norton (2004) notes, "*there is an international consensus that high rates of protection not only invite retaliatory protection measures but also lead to inefficiencies in a country's own production structure, by removing the pressure for productivity increases and for reallocating a country's productive resources to its more competitive product lines*". Given this insight, several steps are required to overcome the shortcomings of the market place. There should be an elimination of import and export subsidies to encourage the breeder-driven market place to determine the appropriateness of indigenous or exotic breeds. Better market information concerning the value of various genetic resources is required. Markets should be open allowing a free flow of germplasm so there will be greater opportunities to increase the utilization of genetic diversity, particularly as consumer demand shifts to regionally-produced products (de Haan, *et al.*, 1997).

Access to technology/information also provides an opportunity to correct market failures. As mentioned previously, correcting the manner in which breeds are evaluated should provide all

livestock producers with a much clearer perspective on how breeds will perform in a given production system. There is also a need to employ other technologies such as assisted reproductive technologies. Some of these technologies have become routine and require much less technical training than once perceived. Given past experiences (Madalena *et al.*, 2002), there is a significant need to blend the utilization of various technologies with local breeding expertise. A component of such a policy could be the strengthening of breeding organizations where breeders reach a consensus on AnGR use and the breeding strategies necessary to achieve economic growth. If a country does determine it beneficial to establish *ex-situ*/cryopreserved collections there will be a need for varying degrees of training. Furthermore, by taking this approach the country allows breeders an effective mechanism to make use of specific AnGR and create new marketing opportunities.

## Policies integrating Conservation, Demand, and Environment

There are policies by which the nexus of AnGR, environmental concerns, and consumer demand can be addressed and fit within the framework described. One such policy is the establishment of clear title to land ownership or use. Land title cuts across the areas of incentives to produce and provides livestock producers with a secure resource base from which to produce livestock. Furthermore, it promotes a balance between the production potential of livestock (and thereby genotypes) and the environmental capacity of their resource. It will permit owners of grazing based livestock to match land use with ecological processes so as to exploit the temporal and spatial variation of key resources and therefore promote opportunities for both livestock production and wildlife. Knowledge of the resource capacity also allows producers to better match genotypes to specific environments, and in determining if new genotypes are to be introduced what type of external inputs are needed to achieve success.

Elimination of market distortions, such as under-valued prices on breed importation schemes, is also a cross-cutting policy affecting livestock producers' incentive to produce and maintain indigenous genetic resources, improved market access for inputs and outputs and the mitigation of

negative impacts of the environment. Elimination of subsidies or distorted prices on genetic resources will level the playing field for all breed types. Without such influences breeders should be in a better position to evaluate the ramifications of utilizing existing genetic resources or modifying their populations through within breed selection, crossbreeding, or breed substitution.

Improving market structures to provide producers with access to inputs, outputs and new technologies is also important. This includes the prospect of access to international exchange and utilization of animal genetic resources. Providing breeders/livestock keepers with access and stable markets allows them the opportunity to search for and evaluate potentially beneficial genetic resources, thereby responding to increased consumer demand, intensifying production, and lowering environmental impacts. In addition, having secured market channels has been deemed a necessary element for adjusting extensive grazing system stocking rates during times of drought.

Conserving AnGR should not be considered juxtaposed to the implementation of new technologies that can promote intensification. Through appropriate intensification there will be reductions of resource use and waste emissions across the board (Steinfeld *et al.*, 2006). Furthermore, livestock products can be tailored to various consumer groups as part of the intensification process. But for appropriate technologies to emerge, national research organizations must be strengthened and public-private linkages must be fostered and enhanced.

Economic and environmental pressures to utilize alternative AnGR will continue and producers are likely to shift to such AnGR, where they deem appropriate. As a result, developing *ex-situ*/cryopreserved stores of genetic resources may need to become a primary mechanism for conserving diversity. By building such *ex-situ*/cryopreserved collections producers have the opportunity to adjust breeding stock to meet the realities of the livestock revolution, while being assured that AnGR used in the past are secure and available for future use if needed. This type of public facilitation role fits well with concepts discussed earlier in this paper (Norton, 2004; Madalena *et al.*, 2002). It has often been suggested that infrastructure and human capacity are lacking to put such repositories in place and that they are more costly than *in-situ* conservation. However, no comprehensive comparison has been performed. It could well be that *ex-situ*/cryopreservation collections have high initial investment costs but



lower recurrent costs, when compared to *in-situ* conservation. Furthermore, globally a number of within country capacities exist and with little additional effort resources can be brought to bear for implementing this type of conservation program.

## Conclusion

Global demand for livestock products, the need to mitigate environmental degradation and national economic growth agendas requires maximum use of AnGR. Yet after one decade of becoming aware of the growing consumer demand, it appears that supply is not keeping pace. In addition, long term livestock - environmental issues (e.g., resource degradation due to grazing) remain unresolved. Increased productivity will require the utilization of more commercialized, higher-producing AnGR that will in turn create more short term pressure on AnGR diversity. Furthermore, the literature suggests that by increasing animal productivity, which may require the utilization of new breeds or intensive selection within indigenous breeds, negative environmental impacts can be mitigated. Considering these pressures breeders will have to capitalize on indigenous breed adaptability while selecting for traits that meet consumer demands for indigenous AnGR to be competitive. As a result of the convergence of the major issues discussed in this paper, policies concerning AnGR should be put in the context of three categories: incentives to produce, securing the resource base, and providing access to markets for inputs and outputs. In making these assignments, potential policies also need to consider the impact they may have on the environment. To meet the current economic, environmental and conservation challenges there is perhaps a need to assess productivity from another perspective, such as life-time productivity and ability to withstand environmental stressors (e.g., drought and disease). There are significant informational needs (e.g., phenotypic/genotypic descriptors, database development, status of breeder capacity) all of which contribute to making more informed choices concerning genetic resource use, as well as solving livestock product demand and environmental issues.

While some have advocated restrictive trade policies as a mechanism to protect indigenous genetic resources, the body of literature on trade indicates that such approaches are not conducive to economic growth and development. Such practices impede the opportunity to encourage producers in other countries to evaluate and utilize the AnGR in

question. In addition to trade restrictions, there has also been a call for so-called access and benefit sharing agreements, the benefits of which are unknown. But, if perceived discrepancies exist between buyer and seller, these are without question a failure of market information and should be resolved by correcting marketing issues and information flow rather than imposing more restrictive policies that will harm the livestock sector's growth. In summary, advancement of policies for AnGR will require a clear statement of the value of AnGR, policies that support breeders in making informed choices about the use of AnGR, development of *ex-situ*/cryopreserved germplasm collections and placing AnGR policies in the context of larger national agendas that address economic growth, consumer demand and environmental sustainability.

## Acknowledgments

The author wishes to thank Dr. Arthur Mariante for his constructive comments and Dr. Carlos Mezzadra for his contribution to an earlier paper on this subject.

## List of References

- Asner, G. P., A. Elmore, L. Olander, R. Martin & A. Harris. 2004. Grazing systems, ecosystem responses, and global change. *Annual Review of Environment and Resources*. 29: 261-299.
- Blackburn, H.D. & T.C. Cartwright. 1987. Simulated genotype, environment and interaction effects on performance characters of sheep. *J. Anim. Sci.* 65: 399-408.
- Blackburn, H.D., K. Zessin, J.F. Taylor, T.C. Cartwright & B.A. Mwandotto. 1990. Flock dynamics during drought and recovery years. Proc. 8<sup>th</sup> SR-CRSP Scientific Workshop. Nairobi, pp. 15-28.
- Blackburn, H.D & J.F. Taylor. 1990. Simulation of flock performance when different intensities of selection are practiced. 4<sup>th</sup> WCGALP. 15: 127-130.
- Blackburn, H. 1995. Comparison of performance of Boer and Spanish Goats in two U.S. locations. *J. Anim. Sci.* 73: 302-309.

- Blackburn, H., S. Lebbie & A. van der Zijpp.** 1998. Animal genetic resources and sustainable development. 6<sup>th</sup> WCGALP. 28: 3-10.
- Blackburn, H.** 2006. The National Animal Germplasm Program: Challenges and opportunities for poultry genetic resources. Poultry Sci. 85: 210-215.
- Blackburn, W.H., R. Knight & M. Wood.** 1982. Impact of Grazing on Watersheds; A State of Knowledge. Texas Agric. Exp. Sta. MP 1496, pp. 32.
- Cundiff, C.V.** 2005. Tropically adapted breeds – Regional Project S-1013. Southern Cooperative Series Bulletin, pp. 131-143.
- de Haan, C., H. Steinfeld & H. Blackburn.** 1997. Livestock and the Environment: Finding a Balance. WREN media, Suffolk, UK, pp. 115.
- Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui & C. Courbois.** 1999. Food, Agriculture, and the Environment Discussion Paper 28. Int'l. Food Policy Res. Inst., pp. 72.
- FAO.** 2000. World Watch List for Domestic Animal Diversity, 3rd. Edition, FAO, Rome, Italy.
- FAO.** 2007. The State of the World's Animal Genetic Resources for Food and Agriculture. FAO, Rome, Italy.
- Gollin, D. & R. Evenson.** 2003. Valuing animal genetic resources: lessons from plant genetic resources. Ecological Economics. 45: 353-364.
- Gibson, J. & R. Pullin.** 2005. Conservation of livestock and fish genetic resources: joint report of two studies commissioned by the CGIAR Science Council. Science Council Secretariat. ([www.sciencecouncil.cgiar.org/activities/spps/pubs/AnFiGR%20study%20report.pdf](http://www.sciencecouncil.cgiar.org/activities/spps/pubs/AnFiGR%20study%20report.pdf)).
- Hanson, J. D., B.B. Baker & R.M. Bourdon.** 1993. Comparison of the effects of different climate change scenarios on rangeland livestock production. Agric. Systems, 41: 487-502.
- Ismali, T. & C.D. Thai.** 1990. Report on the Small Ruminant Collaborative Research Support Project (SR-CRSP) Indonesia Workshop. US Agency for International Development, Washington, DC.
- Kanis, E., K. De Greef, A. Hiemstra & J. van Arendonk.** 2005. Breeding for societally important traits in pigs. J. Anim. Sci. 83: 948-957.
- Kolmodin, R., E. Strandberg, H. Jorjani & B. Danell.** 2002. Selection in presence of genotype by environment interaction may increase environmental sensitivity. 7<sup>th</sup> WCGALP. 32: 333-336.
- Leng, R.A.** 1991. Improving Ruminant Production and Reducing Methane Emissions from Ruminants by Strategic Supplementation. U. S. Environmental Protection Agency, Washington, D.C. EPA/400/1-91/004.
- Madalena, F., K. Agyemang, R. Cardellino & G. Jain.** 2002. Genetic improvement in medium- to low-input systems of animal production. Experiences to date. 7<sup>th</sup> WCGALP. 33: 331-340.
- Mendelsohn, R.** 2003. The challenge of conserving indigenous domesticated animals. Ecological Economics. 45: 501-510.
- Misztal, I. & O. Ravagnolo.** 2002. Studies on genetics of heat tolerance in Holsteins. 7<sup>th</sup> WCGALP. 32: 345-348.
- Norton, R.** 2004. Agriculture Development Policy: Concepts and Experiences. FAO, Rome.
- Rege, J. & J. Gibson.** 2003. Animal genetic resources and economic development: issues in relation to economic valuation. Ecological Economics. 45: 319-330.
- Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales & C. de Haan.** 2006. Livestock's long shadow: environmental issues and options. FAO, Rome, Italy.
- Souza, J., A. Ramos, A. Silva, K. Euclides Filho, M. Alenctar, F. Wechsler, C. Gadini & L. Van Vleck.** 1998. Effect of genotype x environment interaction on weaning weight of Nelore calves raised in four different regions of Brazil. 6<sup>th</sup> WCGALP. 23: 193-196.
- Tiffen, M., M. Mortimore & F. Gichuki.** 1994. More People, Less Erosion: Environmental Recovery in Kenya. John Wiley & Sons, Chichester, UK.
- Wollny, C.** 2003. The need to conserve farm animal genetic resources in Africa: should policy makers be concerned? Ecological Economics. 45: 341-352.

## What's on the menu? Options for strengthening the policy and regulatory framework for the exchange, use and conservation of animal genetic resources<sup>1</sup>

S.J. Hiemstra<sup>1</sup>, A.G. Drucker<sup>2</sup>, M.W. Tvedt<sup>3</sup>, N. Louwaars<sup>1</sup>, J.K. Oldenbroek<sup>1</sup>, K. Awgichew<sup>4</sup>, S. Abegaz Kebede<sup>5</sup>, P.N. Bhat<sup>6</sup> & A. da Silva Mariante<sup>7</sup>

<sup>1</sup>Centre for Genetic Resources, the Netherlands (CGN) of Wageningen University and Research Centre, the Netherlands. P.O. Box 65, 8200 AB Lelystad, the Netherlands

<sup>2</sup>School for Environmental Research, Charles Darwin University, Darwin, Australia

<sup>3</sup>The Fridtjof Nansen Institute, P.O. Box 326, 1326 Lysaker, Norway

<sup>4</sup>Institute of Biodiversity Conservation, P.O.Box 30726, Ethiopia

<sup>5</sup>Ambo College, P.O. Box. 19, Ambo, Ethiopia

<sup>6</sup>World Buffalo Trust (WBT), 201 303 Noida (UP), India

<sup>7</sup>EMBRAPA Cenargen, Brasilia DF, Brazil

### Summary

This paper addresses major issues and challenges for Animal Genetic Resources (AnGR) and the livestock sector, as well as options for further development of policies or regulatory approaches. Three main areas were identified, i) how we can halt the further erosion of genetic diversity and promote sustainable breeding and use, ii) whether there is a need to regulate the exchange of genetic material and iii) how to balance different systems of rights (e.g. sovereign rights of nations, intellectual property rights, communal rights or rights of livestock keepers).

To halt further erosion, complementary *ex-situ* and *in-situ* conservation approaches are needed and breeding and marketing of local breeds should be strengthened. Secondly, recognizing the importance of the exchange of AnGR, broad access and responsible and equitable exchange mechanisms should be further promoted. Thirdly, regarding intellectual property rights, there is a need to adapt the application of the patent system to the special circumstances inherent in animal breeding. Moreover, possible *sui generis* systems should be

further explored in order to better balance different rights systems.

Rather than developing a new or adapted internationally legally binding framework, the intergovernmental process under FAO may instead wish to focus, in the first instance, on the development of voluntary instruments to strengthen national policies and the implementation of action at national levels.

Debates and developments related to international agreements in the crop sector have also tended to frame the debate for AnGR. However, before launching into a discussion on whether or not an 'FAO Animal Treaty' would be needed, one should first of all clarify the problems to be dealt with and regulated via an international regime.

### Résumé

Cet article rassemble les thèmes principaux et défis des Ressources Génétiques Animales (AnGR) et du secteur élevage, ainsi que les options disponibles pour le développement de politiques ou règlements.

<sup>1</sup>This paper summarizes the main findings of a study entitled 'Exchange, Use and Conservation of Animal Genetic Resources: Policy and Regulatory Options'. Report 2006/06. Centre for Genetic Resources, the Netherlands (CGN), Wageningen University and Research Centre. The study was commissioned by FAO and funded by the Government of the United Kingdom of Great Britain and Northern Ireland, through DFID. The views expressed in the report and in this paper are the sole responsibility of the authors. The full report is downloadable from:

<http://www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/>

<http://www.cgn.wur.nl/UK/CGN+General+Information/Publications/2006/>

[http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR\\_policy\\_and\\_regul.pdf](http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR_policy_and_regul.pdf)

On a identifié trois domaines principaux:

1. Comment empêcher l'érosion de la diversité génétique et promouvoir l'utilisation et l'élevage durable.
2. Quand est-il nécessaire de réglementer les échanges de matériel génétique.
3. Comment adapter les différents systèmes législatifs (p.e. les droits souverains au niveau national, les droits sur la propriété intellectuelle, les droits communs ou droits des éleveurs).

Pour empêcher une érosion ultérieure des études complémentaires *in-situ* et *ex-situ* seront nécessaires, ainsi qu'un renforcement de la sélection et commercialisation des races locales. En deuxième lieu, et tenant compte de l'importance des échanges de AnGR, on devrait promouvoir un majeur accès et des mécanismes responsables et équitables. Pour finir, en ce qui concerne les droits de la propriété intellectuelle, il faudrait adapter l'application des systèmes de brevet aux circonstances spéciales inhérents au secteur de l'élevage animal.

Cependant, on pourrait rechercher d'autres systèmes possibles *sui generis* afin de mieux adapter les différents systèmes législatifs. Au lieu de développer un nouveau système ou adapter un cadre légal au niveau international, le procès intergouvernemental sous la supervision de la FAO voudrait centrer le thème en principe sur le développement d'outils volontaires qui renforceraient les politiques nationales et la mise en oeuvre d'actions au niveau national. Les débats et développements en relation avec les accords internationaux dans le domaine agricole ont contribué aussi à l'encadrer dans les AnGR.

Cependant avant d'initier une discussion sur l'opportunité ou moins d'établir un "Traité FAO sur les animaux" il serait nécessaire d'identifier les problèmes auxquels il faudra faire face et comment les réglementer à travers un accord international.

3. Cómo adaptar los distintos sistemas legales (p.e. los derechos soberanos a nivel nacional, los derechos de la propiedad intelectual, los derechos comunales o derechos de los ganaderos).

Para impedir una erosión ulterior serán necesarios estudios complementarios *in-situ* y *ex-situ*, así como un reforzamiento de la cría y comercialización de las razas locales. En segundo lugar, teniendo en cuenta la importancia de los intercambios de AnGR, se debería promover un mayor acceso y mecanismos responsables y equitativos. Por fin, en lo relativo a los derechos de la propiedad intelectual, sería necesario adaptar la aplicación del sistemas de patentes a las circunstancias especiales inherentes al sector de la cría animal. Sin embargo, se podrían investigar ulteriores posibles sistemas *sui generis* con el fin de adaptar mejor los distintos sistemas legales. En vez de desarrollar un nuevo sistema o adaptar un marco legal a nivel internacional, el proceso intergubernamental bajo supervisión de la FAO desearía enfocar el tema en un principio en el desarrollo de instrumentos voluntarios que reforen las políticas nacionales y la implementación de las acciones a nivel nacional. Los debates y desarrollos relacionados con los acuerdos internacionales en el sector agrícola también han contribuido a enmarcar el debate en el campo de AnGR. Sin embargo, antes de lanzarse en una discusión sobre la oportunidad o menos de establecer un "Tratado de la FAO sobre animales", se deberían identificar los problemas que se encontraran y cómo reglamentarlos a través de un acuerdo internacional.

**Keywords:** AnGR, Policy and Regulatory Options, Exchange, Conservation, Use, Rights.

## Resumen

Este artículo recoge los temas principales y desafíos de los Recursos Zoogenéticos (AnGR) y del sector ganadero, así como las opciones para el consiguiente desarrollo de políticas o reglamentos. Se identificaron tres áreas principales:

1. Cómo impedir la erosión de la diversidad genética y promover la utilización y cría sostenible.
2. Cuando es necesario reglamentar los intercambios de material genético.

## Introduction

The FAO International Technical Conference on Animal Genetic Resources (AnGR) in Interlaken in 2007 will represent a milestone, finalizing the global assessment on the State of the World's Animal Genetic Resources and providing an opportunity to reach agreement on how best to address priorities for the sustainable use, development and conservation of animal genetic resources for food and agriculture (AnGR). One of the expected outcomes of this Conference is a Global Plan of Action on Animal Genetic Resources, therefore Interlaken will probably be for AnGR what Leipzig was for plant genetic resources for food and agriculture. The overall process, coordinated by

FAO and driven by national governments, should result in action contributing to conservation and sustainable breeding and utilization of AnGR. It is expected that three important issues need to be discussed:

1. How we can halt the further erosion of genetic diversity and promote sustainable breeding and use.
2. Whether there is a need to regulate the exchange of genetic material.
3. How to better balance different systems of rights (e.g. sovereign rights of nations, intellectual property rights, individual or communal ownership rights or access rights to AnGR and natural resources).

Debate on these issues may lead to a decision as to whether an international legally binding mechanism is needed, or if 'softer' arrangements can adequately meet the objectives in a more effective manner.

Although not designed primarily for AnGR, international agreements with a general scope (governed by the Convention on Biological Diversity (CBD), the World Trade Organisation/Trade Related Intellectual Property System (WTO/TRIPS) and the World Intellectual Property Organisation (WIPO)) also apply to AnGR. As their implementation advances further, they may have an increasingly significant impact on AnGR exchange, use and conservation. While the special nature of agricultural biodiversity is recognized, FAO could play a key role in facilitating and informing the debate on specific AnGR needs and challenges.

In 2004, the Intergovernmental Technical Working Group on Animal Genetic Resources<sup>2</sup> recommended that FAO commission a study<sup>3</sup> to assess how exchange practices regarding AnGR affect the various stakeholders in the livestock sector, and to identify policies and regulatory options that guide the global exchange, use and

conservation of AnGR. This paper presents the main findings of the recommended study: policy and regulatory options related to the exchange and the conservation and sustainable use of AnGR. The identification of options is based on literature surveys<sup>4</sup> and stakeholder consultations. A review of the current situation and the exploration of future scenarios served as input for the latter.<sup>5</sup>

## The International Treaty on Plant Genetic Resources (PGR) for Food and Agriculture as an example for AnGR?

Debates and developments related to international agreements in the crop sector have also tended to frame the debate for AnGR. Some argue that it is important to develop a legally binding international agreement for AnGR similar to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) that has been ratified by a growing number of countries. Core elements of this treaty are a multilateral system for the exchange of accessions of plant genetic resources for food and agriculture and the recognition of farmers' rights which are left to countries to implement. The treaty is in line with CBD and regulates specific aspects for plant genetic resources in agriculture. Before launching into a discussion on whether or not an 'FAO Animal Treaty' would be needed, one should clarify which problems need to be regulated or which trends needed to be positively influenced. Key biological, historical, socio-economic and institutional differences between plant and animal genetic resources need to be understood and to be brought into the policy, regulatory and legal discussions about AnGR. The substantial differences between animal and plant breeding

<sup>2</sup> CGRFA/WG-AnGR-3/04/REPORT, paragraph 24

<sup>3</sup> The study, entitled 'Exchange, use and conservation of animal genetic resources: policy and regulatory options' was commissioned by FAO and funded by the Government of the United Kingdom of Great Britain and Northern Ireland, through DFID. The views expressed in the report and in this paper are the sole responsibility of the authors. The full report is downloadable from:

<http://www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/>

<http://www.cgn.wur.nl/UK/CGN+General+Information/Publications/2006/>

[http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR\\_policy\\_and\\_regul.pdf](http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR_policy_and_regul.pdf)

<sup>4</sup> Due to the large number of references, they are listed in the Bibliography section at the end

<sup>5</sup> For further details about future scenario's and stakeholder analysis see also Drucker *et al.* (this volume); a detailed analysis of property rights, exclusive rights and use rights is provided by Tvedt *et al.* (this volume).

strongly suggest that to simply copy the solutions from the plant sector to the animal branch will not provide a suitable solution.

## Halt Further Genetic Erosion and Promote Sustainable Breeding and Use

There is consensus that global AnGR diversity is under pressure. The global livestock sector is increasingly focused on a small number of highly specialized breeds and local breeds are threatened. The existence of threats to farm animal breeds and farm animal genetic diversity is generally accepted,



Figure 1. Dutch Landrace goat, the Netherlands (photo by H.F. Cnossen).

even though debate remains about the severity of genetic erosion. FAO (2007) reported that, globally, 20% of recorded breeds are classified as 'at risk'. On the other hand, the loss of breeds is only one indicator of the loss of farm animal genetic diversity, as a major part of genetic diversity is found within breeds and there is also significant genetic overlap between breeds. Maintenance of *within* breed diversity is as important as *between* breed diversity as a genetic reservoir for future breeding and use. Both commercial breeds and rare breeds sometimes have very limited *within* breed diversity. Therefore, the problem may be bigger than figures of breed loss imply.

Even where diverse animal genetic resources currently have a low 'direct use' value, such resources may nonetheless be particularly valuable for future use. Such 'non-market' values provide a key justification for the public sector to play an important role in their conservation and management. However, there is limited awareness about the importance of conservation and the sustainable use of AnGR among policy makers and major stakeholders in the livestock sector.

To halt further genetic erosion, complementary *ex-situ* and *in-situ* conservation approaches are needed, to be organized at national, regional and/or global levels. The major responsibility for the conservation and sustainable use of AnGR lies at the national level (according to the CBD).

However, coordination and collaborative arrangements at regional and/or global levels are also likely to be important.

*Ex-situ* conservation could either support *in-situ* conservation and breeding in the short term or may have a long term (insurance) objective. *Ex-situ* approaches require appropriate infrastructure, organization, technical capacity, agreed priorities, sustained funding and (new) legal arrangements regarding ownership and the use of germplasm.

In many countries there is a lack of human resources and institutional capacity in animal breeding. Lack of effective, sustainable breeding programs

for local breeds may be one of the reasons that such breeds lose their competitive advantage, especially where production systems or external conditions are subject to change. Poor marketing and breed promotion is also an important limiting factor for the continued use of valuable breeds. Without interventions and the strengthening of breeding capacity for local breeds, the current threat to the survival of local AnGR is inevitably going to escalate. Within-breed diversity in both local and international breeds may also decline without proper consideration of inbreeding issues and sustainable long term breeding goals.



Figure 2. Yak, Bhutan (photo S.J. Hiemstra).

## Responsible and equitable exchange mechanisms

Exchange of genetic material between countries and regions over millennia has been a very valuable mechanism for breed and livestock development. Countries and regions are highly interdependent, and continue to need broad access to AnGR for their livestock development. However, there have also been direct or indirect negative effects on farm animal genetic diversity.

A tremendous amount of AnGR exchange currently takes place between developed countries ('North' to 'North') while globalization drives the exportation of high performing breeding stock from 'North' to 'South'. 'South' to 'South' exchange has also been extensive and important for livestock development but less well documented than 'North' to 'North' exchange. Movements of livestock germplasm from 'South to North' have been rare in the past century. The latter practice is in stark contrast to plants, where South to North flows are prominent, driven by the search for disease resistance and adaptive genes for new plant varieties. This important difference in the gene flow direction is likely to influence discussions on the regulation of exchange.

The exchange of AnGR is currently mainly regulated through the transfer of private ownership

(by private law contracts and customary law) and is also influenced by zoo-sanitary regulations. Some countries have specific access regulations or regulations to assess the potential impact of AnGR introductions in the country.

## Zoo-sanitary regulations

Zoo-sanitary regulations are considered to be the main constraints to exchange. In order to avoid frustrating the exchange of AnGR, further harmonization of

*zoo-sanitary laws* should continue at regional and global levels. Special attention should be given to the use of resources cry-conserved in the past.

## Impact assessment

There are examples of the damaging effects of introducing exotic material from North to South to improve local breeds. The existence of genotype x environment interactions, and the avoidance of undesired effects of exchange, may trigger the need to *assess the (genetic) impact* of import/export on sustainable (livestock sector) development in the country. Such an instrument may be worth considering as a basis for putting in place strategies to support the mitigation of potential negative side-effects of particular exchange practices. Application of a (voluntary) 'code of good practice' would be useful in this context, creating stronger responsibilities for both exporters and importers. Genetic impact assessments (both positive and negative) could also be extended to include economic and livelihood impacts as well as other developmental and/or environmental impacts. A potential disadvantage that would have to be overcome is the likelihood of increased bureaucracy, thereby blocking imports and reducing livestock sector development opportunities.

## Access and benefit sharing

It is a general belief that the current exchange of AnGR has generated benefits for both seller and buyer under the present circumstances where private law agreements have been in use. However, there are some cases where stakeholders consider that benefit sharing has not been sufficiently catered for. There are cases where the value in further breeding turned out to significantly outweigh the purchase value of the exported breeding animal or germplasm. The CBD presupposes the right of a country to exercise sovereign control over its AnGR (accompanied by a number of responsibilities). An exporting country may wish to maintain property rights over the AnGR after the resources have left the country. Even if the animals and breeding material are under private ownership, states have, according to the CBD, the right to regulate export. It can be argued that private parties agree on benefit sharing when AnGR is being transferred by a private law agreement. An *export regulation* could however set rules or a minimum standard for the content of a private law agreement to be considered legal or valid.

An *export regulation* could provide a useful supplementary tool for private law agreements, in particular in situations where negotiating capacities or market positions are significantly unequal. Two countries who commonly trade AnGR could also decide to develop a *bilateral framework agreement* aimed at facilitated exchange, following a pre-negotiated set of rules.

Development of a *model Material Transfer Agreement* (model MTA) at the international level,



Figure 4. Groningen White Headed cattle, the Netherlands (photo by H.F. Cnossen).



Figure 3. Cover of the Report "Exchange, use and conservation of animal genetic resources: policy and regulatory options". Report 2006/06.

largely based on current exchange practices as well as covering all important negotiation issues relevant to AnGR exchange, would also be useful, in order to support the responsible exchange of AnGR. Development of such a *model MTA* may become particularly important if patterns of gene flow were to change substantially in the future. Private law guided exchange could be supplemented by a *model MTA* which would supplement the fragmented use of contracts today.

Following the negotiations in the CBD regarding an International Binding Regime for Access and Benefit Sharing, there is a need to survey how these changes in the international legal order for the exchange of genetic resources in general will affect



the exchange of AnGR in particular. Development of an international agreement on a *standard MTA* for AnGR could be a response to CBD developments and to unequal negotiating capacities and the market dominance of larger commercial entities in the livestock sector. A MTA for AnGR should reflect the significant differences between plant and animal genetic resources.

## Intellectual Property Rights and Use Rights

Genetic flows have changed over time, genetic diversity is under pressure, and the power between stakeholders is increasingly unbalanced. Further concentration and vertical integration in the livestock industry, combined with the protection of investments through the use of intellectual property rights are generating an increased concern about *equity* and may seriously affect the positions of livestock keepers, small farmers and (small scale) breeders.

Today, almost all farm animal genetic resources are under private control and ownership and not considered to be in the public domain. However, breeds are 'public' in the sense that governments often recognize them as distinct breeds. Commercial breeders generally 'protect' their investments by 'staying ahead' of competing breeders, through physical control of the use of their breeding animals and the use of private law contracts. The use of Intellectual Property Rights (IPR) in animal breeding has to date mainly been focused on *trademarks*. Developments in patenting in some countries have triggered discussions about the potential impact of patenting on animal breeding methods and animal genes and cells. This has also started a discussion about the need to define the *rights* of livestock keepers/farmers/breeders over the AnGR they have developed over time and about access rights to AnGR and natural resources. An increasing tension is apparent between existing *physical ownership* or *communal ownership* to AnGR and increased use of the patent system in the commercial breeding sector. Regarding developments in the patent system, concerns have been raised that a high number of patent claims and the broad scope of the claims may lead to a significant body of *exclusive rights* on knowledge and breeding technology with substantial impacts on the use of AnGR.



Figure 5. Drenthe fowl, the Netherlands (photo by F. van Welie).

## Exclusive rights

There is considerable concern that patents be granted to existing methods – although they may not sufficiently disclosed to qualify as *prior art* in the patent system. To counterbalance the effect of excessive patenting, *preventive publishing* is often put forward as a strategy to ensure that common knowledge will be considered *prior art*. However, the ability to exploit even small adaptations to what was originally published (i.e. 'patenting around the prior art') means that such an approach may be an ineffective counterbalance in practice. Other alternatives could be to oblige patent offices to take into account specific AnGR *prior art/novelty/inventiveness guidelines* and/or having countries introduce specific *exemptions* in national patent law, such as *farmers' privilege* or *breeder's exemption*. A systematic legal analysis would be advisable to assess how general patent law rules apply to AnGR and breeding. There is also a need for analyzing the effects patents might have on research and investments in the animal sector; and eventually it may be worth considering the degree to which patent protection is needed at all in the animal

sector, to promote breeding, research and development in the livestock sector.

### ***Sui generis* protection**

The present system of *plant breeders' rights* (UPOV) provides protocols for assessing and describing the unique characteristics of a new plant variety, ensuring that it is distinct, uniform and stable. Such a system is unlikely to be applicable to farm animal breeds in the same way as it is for plants. *Sui generis* protection systems could nonetheless be useful. Establishment of *breed associations or herd book registration* (governed by breeding laws) combined with *trademark* protection would be a good alternative for breed conservation and property right protection. A *sui generis* protection could also be linked to special geographical related properties and characteristics of the animals or their products (*geographical indications*).

### **Conclusions**

Based on analysis of the existing policy frameworks, and as potential solutions to the problems raised during the stakeholder consultations, a number of possible policy and regulatory options for AnGR were identified during the study. These should be considered within the context of an informed debate regarding the need for strengthening the existing policy and regulatory framework for AnGR, as well as in terms of the *form* that any such strengthening should take. With regard to the latter, rather than developing a new or adapted internationally legally binding framework, the intergovernmental process under FAO may instead wish to focus, in the first instance, on the development of voluntary instruments to strengthen national policies and the implementation of action at national levels. This could be carried out in parallel with further analysis of how other international regimes may influence AnGR. The Interlaken Conference is expected to raise the level of awareness on the many roles and values of AnGR, and to highlight the special nature of AnGR, their distinctive features, and problems needing distinctive solutions.

### **Acknowledgements**

We are grateful to FAO for commissioning this study, and to the Government of the United Kingdom of Great Britain and Northern Ireland for funding it through the Department for International Development DFID. We also thank the members of the steering committee, I. Hoffmann (FAO) and T. Brown (DFID) for their inputs and contributions.

### **List of References**

- CBD.** 1992. Convention on Biological Diversity. Available at: [www.biodiv.org](http://www.biodiv.org).
- CBD.** 2002. Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization.
- Drucker, A.G., V. Gomez & S. Anderson.** 2001. The Economic Valuation of Farm Animal Genetic Resources: A Survey of Available Methods. *Ecological Economics*. Vol. 36 (1): 1-18.
- Drucker, A.G., M. Smale & P. Zambrano.** 2005. Valuation and Sustainable Management of Crop and Livestock Biodiversity: A Review of Applied Economics Literature. SGRP/IFPRI/ILRI, [www.ilri.org](http://www.ilri.org).
- Esquinas-Alcazar, J.** 2005. Protecting crop genetic diversity for food security: political, ethical and technical challenges. *Science & Society: Nature Review Genetics* 6, 946-953.
- FAO.** 1999. The global strategy for the management of farm animal genetic resources. FAO. Rome.
- FAO.** 2005. The legal framework for the management of animal genetic resources. FAO Legislative Study 89. ISSN 1014-6679. ISBN 92-5-105433-9. Ingressia, A., Manzella, D. & Martyniuk, E. (Eds), Food and Agriculture Organization of the United Nations, Rome, 2005.
- FAO.** 2007. The State of the World's Animal Genetic Resources. B. Rischkowsky and D. Pilling (Eds).
- Gibson, J.P. & S.V. Pullin.** 2005. Conservation of Livestock and Fish Genetic Resources. Gibson, J.P. and Pullin, S.V. Science Council Secretariat, FAO.

- Gibson, J., S. Gamage, O. Hanotte, L. Iniguez, J.C. Maillard, B. Rischkowsky, D. Semambo & J. Toll.** 2006. Options and Strategies for the Conservation of Farm Animal Genetic Resources: Report of an International Workshop (7-10 November 2005, Montpellier, France). CGIAR System-wide Genetic Resources Programme (SGRP)/Bioversity International, Rome, Italy, pp. 53.
- Hiemstra, S.J., A.G. Drucker, M.W. Tvedt, N. Louwaars, J.K. Oldenbroek, K. Awgichew, S. Abegaz Kebede, P.N. Bhat & A. da Silva Mariante.** 2006. Exchange, use and conservation of animal genetic resources: policy and regulatory options. Report 2006/06. Centre for Genetic Resources, the Netherlands (CGN), Wageningen University and Research Centre, the Netherlands; [www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/](http://www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/); <http://www.cgn.wur.nl/UK/CGN+General+Information/Publications/2006/>; [www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG\\_AnGR4/AnGR\\_policy\\_and\\_regul.pdf](http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG_AnGR4/AnGR_policy_and_regul.pdf)
- Hoffmann, I. & B. Scherf.** 2005. Management of farm animal genetic diversity: opportunities and challenges. WAAP Book of the Year 2005, pp. 221-245.
- ITPGRFA.** 2004. International Treaty on Plant Genetic Resources for Food and Agriculture, FAO, Rome, 2004. Available at [www.fao.org](http://www.fao.org) (full web link).
- LID.** 1999. Livestock in poverty-focused development. Livestock in Development. Crewkerne, UK.
- LPP.** 2003. Karen Commitment. Pastoralist/Indigenous Livestock Keepers' Rights. Kenya, 27-30 October, 2003; [www.pastoralpeoples.org/docs/karen.pdf](http://www.pastoralpeoples.org/docs/karen.pdf).
- Mathias, E. & P. Mundy.** 2005. Herd movements: The exchange of livestock breeds and genes between North and South. League for Pastoral Peoples and Endogenous Livestock Development; [www.pastoralpeoples.org/docs/herdmovements.pdf](http://www.pastoralpeoples.org/docs/herdmovements.pdf)
- Notter, D.R.** 2004. Conservation strategies for animal genetic resources. Background Study Paper No. 22. Commission on Genetic Resources for Food and Agriculture, FAO, October 2004.
- Rege, J.E.O. & J. Gibson.** 2003. Animal genetic resources and economic development: issues in relation to economic valuation. *Ecological Economics* 45 (3), 319-330.
- Rosendal, G.K., I. Oleson, H.B. Bentsen, M.W. Tvedt & M. Bryde.** 2005. Strategies and Regulations Pertaining to Access to and Legal Protection of Aquaculture Genetic Resources. The Fridtjof Nansens Institute, October 2005.
- Rothschild, M.F., G. Plastow & C. Newman.** 2003. Patenting in animal breeding and genetics. WAAP Book of the Year 2003, pp. 269-278.
- Sainath, P.** 1996. Everybody Loves a Good Drought. Stories from India's Poorest Districts. Penguin Books, 1996.
- Sere, C., H. Steinfeld & J. Groenewold.** 1996. World Livestock Production Systems. Current status, issues and trends. FAO Animal Production and Health Papers 127. FAO. Rome, Italy.
- Stannard, C., N. van der Graaf, A. Randall, P. Lallas & P. Kenmore.** 2004. Agricultural biological diversity for food and agriculture: shaping international initiatives to help agriculture and the environment. *Howard Law Journal*, vol. 48, no. 1. Ed. Howard University School of Law.
- Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales & C. Haan.** 2006. Livestock's long shadows. Environmental issues and options. FAO; [www.virtualcentre.org/en/library/key\\_pub/longshad/A0701E00.pdf](http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf)
- Tisdell, C.** 2003. Socioeconomic causes of loss of animal diversity genetic: analysis and assessment. *Ecological Economics* 45 (3), 365 -376.
- TRIPS.** Agreement on Trade-Related Aspects of Intellectual Property Rights; available at: [www.wto.org](http://www.wto.org).
- Tvedt, M.W.** 2005. How will a substantive patent law treaty affect the public domain for genetic resources and biological material? *The Journal of World Intellectual Property*, vol. 8 no. 3, 311-344.
- Tvedt, M.W.** 2006. Element for Legislation in User Country to Meet the Fair and Equitable Benefit-Sharing Commitment. *The Journal of World Intellectual Property*, vol. 9, no. 2., 189-212.

.....

**Tvedt, M.W. & T.R. Young.** 2006 (Forthcoming). Beyond Access – A Legal Analysis of the Fair and Equitable Benefit Sharing Commitment in the CBD. IUCN.

**UPOV.** 1991. International Union for the Protection of New Varieties of Plants; available at [www.upov.int](http://www.upov.int).

**Valle Zárate, A., K. Musavaya & C. Schäfer.** 2006. Gene flow in animal genetic resources. A study on status, impact and trends. Institute of Animal Production in the Tropics and Subtropics, University of Hohenheim, Germany.

**Verrier, E., M. Tixier-Boichard, R. Bernigaud & M. Naves.** 2005. Conservation and value of local livestock breeds: usefulness of niche products and/or adaptation to specific environments. *Animal Genetic Resources Information*, no. 36, 2005.

**Woolliams, J. & M. Toro.** 2007. What is genetic diversity? In: *Utilisation and Conservation of Farm Animal Genetic Resources*. K. Oldenbroek (Ed.). Wageningen Academic Publishers.

## Back to the future. How scenarios of future globalisation, biotechnology, disease and climate change can inform present animal genetic resources policy development

A.G. Drucker<sup>1</sup>, S.J. Hiemstra<sup>2</sup>, N. Louwaars<sup>2</sup>, J.K. Oldenbroek<sup>2</sup>, M.W. Tvedt<sup>3</sup>, I. Hoffmann<sup>4</sup>, K. Azwigichew<sup>5</sup>, S. Abegaz Kebede<sup>6</sup>, P.N. Bhat<sup>7</sup> & A. da Silva Marianne<sup>8</sup>

<sup>1</sup>School for Environmental Research, Charles Darwin University, Darwin, Australia

<sup>2</sup>Centre for Genetic Resources, the Netherlands (CGN) of Wageningen University and Research Centre, Wageningen, The Netherlands

<sup>3</sup>The Fridtjof Nansen Institute, P.O. Box 326, 1326 Lysaker, Norway

<sup>4</sup>Animal Production Service (AGAP), FAO, Rome, Italy

<sup>5</sup>Institute of Biodiversity Conservation, P.O.Box 30726, Ethiopia

<sup>6</sup>Ambo College, P.O. Box. 19, Ambo, Ethiopia

<sup>7</sup>World Buffalo Trust (WBT), 201 303 Noida (UP), India

<sup>8</sup>EMBRAPA Cenargen, Brasilia DF, Brazil

### Summary

With the aim of assessing how exchange practices regarding Animal Genetic Resources for Food and Agriculture (AnGR) affect the various stakeholders in the livestock sector and to identify policies and regulatory options that could guide the global exchange, use and conservation of AnGR, an exploration of future scenarios was used as a complementary approach to reviewing the current situation, as well as to identify stakeholders' views on AnGR policy development.

Four 2050 future scenarios were developed and included:

1. Globalization and regionalization.
2. Biotechnology development.
3. Climate change and environmental degradation.
4. Diseases and disasters.

Having developed the scenarios, these were then used as an input point for a wide range of stakeholder consultations.

The findings show that such an approach has been a useful analytical tool. The 'far' future perspective appeared to make people less defensive, especially in a situation where current exchange problems were not yet particularly visible or well documented. Many interviewees broadly considered that it was not a question of 'if' the scenarios would happen, but rather a question of 'when'. This implies that we might do well to consider the need to respond to future challenges through the proactive development of new policies or regulations. Such a finding is partly in contrast

with the general perception of the current regulatory situation being broadly acceptable.

### Résumé

On a réalisé une enquête sur les possibles futur scénarios comme approche complémentaire pour revoir la situation actuelle et identifier l'avis des intéressés au secteur de l'élevage sur le développement politique des Ressources Génétiques Animales (AnGR) afin d'évaluer comment les modalités d'échange de AnGR dans le domaine de l'alimentation et de l'agriculture ont un effet sur les éleveurs et pouvoir ainsi identifier les politiques et règlements qui peuvent servir de guide dans ces échanges, l'utilisation et la conservation de AnGR au niveau mondial.

On a identifier quatre possibles scénarios futurs qui comprennent:

1. La globalisation et régionalisation.
2. Le développement biotechnologique.
3. Les changements climatiques et dégradation de l'environnement.
4. Les maladies et calamités.

Une fois établis ces scénarios, ils ont été utilisés comme point de départ pour la consultations auprès des éleveurs. Les résultats montrent que cette approche a été un outil utile.

Les perspectives de futur "lointain" montrent la population avec moins de protection, spécialement dans les situations où les problèmes dus aux échanges n'étaient pas visibles ou connus. La

plupart des consultés ont considéré que le problème n'était pas tellement "si" mais plutôt "quand" ces scénarios pourraient se présenter. Ceci implique qu'il faudra très bien considérer la capacité de réaction aux défis dans le futur à travers des initiatives de développement de nouvelles politiques ou règlements. Ce résultat contraste en partie avec la perception générale sur la grande acceptation de la situation réglementaire actuelle.

## Resumen

Se ha realizado una exploración de futuros escenarios como enfoque complementario para revisar la situación actual, así como identificar la visión de las partes interesadas del sector ganadero, sobre el desarrollo político de los Recursos Zoogenéticos (AnGR) con el fin de evaluar cómo las modalidades de intercambio de AnGR en la alimentación y agricultura afectan a los propietarios del sector ganadero e identificar políticas y reglamentos que puedan servir de guía en los intercambios, utilización y conservación de AnGR a nivel mundial.

Se establecieron cuatro escenarios futuros que incluyen:

1. Globalización y regionalización.
2. Desarrollo biotecnológico.
3. Cambios climáticos y degrado ambiental.
4. Enfermedades y calamidades.

Una vez establecidos estos escenarios, se utilizaron como punto de partida para una mayor consulta con los propietarios. Los resultados muestran que este enfoque ha sido una herramienta útil.

Las perspectivas del futuro "lejano" hicieron la gente menos protegidas, especialmente en situaciones en que los problemas debido a los intercambios no eran particularmente visibles o bien documentados. Muchos de los entrevistados consideraron que el problema no era tanto "si" sino "cuando" estos escenarios podían darse. Esto implica que tendremos que considerar muy bien la capacidad de respuesta a los futuros desafíos a

través iniciativas de desarrollo de nuevas políticas o reglamentos. Este resultado se contrapone en parte a la percepción general de la situación reglamentaria actual ampliamente aceptada.

**Keywords:** AnGR, Policy development, Regulatory options, Future scenarios.

## Introduction

Following a recommendation from the Intergovernmental Technical Working Group on Animal Genetic Resources<sup>1</sup>, the FAO commissioned a study<sup>2</sup> (Hiemstra *et al.*, 2006) to assess how exchange practices regarding Animal Genetic Resources for Food and Agriculture (AnGR) affect the various stakeholders in the livestock sector and to identify policies and regulatory options that guide the global exchange, use and conservation of AnGR.

In order to identify present and/or future issues and problems related to the exchange, conservation and sustainable use of AnGR, literature surveys, scenarios and stakeholder consultations were used. A review of the current situation and the exploration of future scenarios served as an input point for stakeholder consultations.

Future scenarios for exchange, use and conservation were used to illustrate plausible future developments (*'histories of the future'*), with the aim of supporting improved decision making in the present about issues that have long-term consequences in the future (Hiemstra *et al.*, 2006). Four 2050 future scenarios were developed. These included: globalization and regionalization; biotechnology development; climate change and environmental degradation; and diseases and disasters. The future scenarios were based on major driving forces, which are not only visible today, but which could have an increasing impact on the exchange, use and conservation of AnGR in the future. Such impacts imply that we might indeed need to respond to future challenges with new

<sup>1</sup>CGRFA/WG-AnGR-3/04/REPORT, paragraph 24

<sup>2</sup>The study, entitled "Exchange, use and conservation of animal genetic resources: policy and regulatory options" was commissioned by FAO and funded by the Government of the United Kingdom of Great Britain and Northern Ireland, through DFID. The views expressed in the report and in this paper are the sole responsibility of the authors. The full report is downloadable from:

<http://www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/>

<http://www.cgn.wur.nl/UK/CGN+General+Information/Publications/2006/>

[http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR\\_policy\\_and\\_regul.pdf](http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR_policy_and_regul.pdf)

policies or regulations, and this is partly in contrast with the general perception of the current situation.

The structure of this paper is as follows. Section II provides an overview of the four 2050 scenarios, while Section III highlights the main findings of the stakeholder consultations based on the discussion of these scenarios. Section IV discusses these findings in the context of their policy and regulatory implications, while Section V provides conclusions about both the findings and the usefulness of the scenarios approach.

## Overview of the Scenarios<sup>3</sup>

The conditions for animal breeding and the conservation of AnGR diversity are changing for a number of reasons. The development of a policy or regulatory framework for AnGR may therefore wish to anticipate future developments. For this reason, four emerging challenges or (potential) future scenarios<sup>4</sup> were developed in order to illustrate plausible future developments (*'histories of the future'*), with the aim of supporting improved decision making in the present about issues that have long-term consequences in the future. Each scenario sub-section starts by highlighting the main driving forces or pillars on which the scenario is built<sup>5</sup>. The future scenario *per se*, as presented to and discussed with the stakeholders is then described.

### 2050 Globalization and regionalization scenario

#### *Driving forces*

Population growth, urbanisation and increased incomes are expected to more than double meat and

milk consumption in developing countries between 1993 and 2020. This 'livestock revolution' will result in a major increase in the share of developing countries in total livestock production and consumption, putting greater stress on grazing resources and triggering more land-intensive production closer to cities. It would also be associated with rapid technological changes and livestock production shifting from a multipurpose activity with mostly non-tradable outputs, to one focused on food production in the context of globally integrated markets.

Globalization<sup>6</sup> trends may be expected to result in a wider use of a limited number of breeds, standardization of consumer products and a move towards large scale production. Retailers and supermarkets will be leading players in the globalization process. Vertical integration is expected to become the primary business model on a global scale. Furthermore, globalization may adversely affect smallholder competitiveness and threaten the sustainable use of local breeds.

#### *The 2050 Scenario*

The globalization of production and trade was effectively promoted by the establishment of the World Trade Organization in 1993 which has a much wider mandate and stronger implementation mechanisms than the GATT. The global economy triggered global product sourcing by processors and retailers in the most powerful markets. This global sourcing led to the standardization of products. Initially, this process started with individual chains such as McDonalds that put in place strict standards for their potatoes, beef, and wheat flour, and which finally led to the exclusive use of prescribed potato and wheat varieties and finally prescribed one animal breed or type of animal for

<sup>3</sup> The scenarios summarised here are based on a more detailed analysis presented in Hiemstra *et al.*, (2006) and related materials. Full details are available from the lead author upon request.

<sup>4</sup> A scenario is defined as a coherent, internally consistent, and plausible description of a possible future state of the world. Scenarios provide alternative views of future conditions considered likely to influence a given system or activity (IPCC, 2001). The scenarios are meant to be plausible, pertinent, alternative stories about the future, with the objective of permitting an exploration of possibilities rather than predicting the future *per se*. In this context, scenarios do not have to turn out to be absolutely correct to be useful.

<sup>5</sup> References from which these driving forces were identified are given under the relevant sections of the Bibliography at the end of this paper.

<sup>6</sup> "Globalisation" is understood to include the international integration of food markets which has generally been observable at the end of the 20<sup>th</sup> century and can be attributed to the liberalization of international commercial policy and the bundle of inter-related technological changes underlying the process (Hobbs and Kerr, 1998).

their global operations. Their example was followed by powerful consortia of retailers.

Parallel to the globalization-led uniformity of products, consumers in the higher segments of the market started to demand regional products with distinct consumption values, supplied through very short chains. Apart from consumption qualities, consumers wanted to support the production function of the local landscape despite scale advantages in production in other parts of the world. The Slow Food movement, which started in a small way at the beginning of the millennium, gained a market share of 5% to 15% in the industrialized world, with the USA at the low end, central Europe and Japan at the higher end and China in between. The Fair Trade movement of the 1990s has connected its initially economic and human welfare objectives with the Slow Food movement, providing northern markets with regionally identified products produced in traditional farming systems.

Globalization has had some adverse consequences, such as the globalization of communicable animal diseases and human health consequences as a result of the over consumption of livestock products by some population sectors, and exposure to livestock waste, as a result of increased livestock product consumption and intensive livestock production, respectively.

The dual development of globalization and regionalization has led to large multinational companies that adapt the production condition to suit the needs of the high productive breeds, lines and hybrids in tightly controlled production chains. Globalization has resulted in an increased demand for breeds with productive traits appropriate for intensive farming systems and consequently a reduced demand for breeds with adaptive traits appropriate for extensive farming systems, thereby increasing the relative importance of conservation measures for the latter.

As an example of these developments, the Bovaria cattle were developed out of a cross between a European breed with excellent growth rate and carcass characteristics and a beef breed from Latin America with excellent meat quality and resistance to heat stress. Bovaria appear to have a wide adaptability to all major beef producing environments ranging from the Argentinean pampas to the saline water irrigated production plains on the Arabic peninsula. Introgression of the heat stress resistance genes left the important meat characteristics unchanged. The breeding company BPAIC (Bovine, Pig and Avian Improvement Company) grew into a multinational body with

strategic alliances with major biotechnology conglomerates and its own gene bank providing the materials for ongoing improvements. BPAIC can be considered a monopolist in the business, but it can avoid anti-trust allegations by pointing to the multitude of local breeding companies and associations maintaining the herd books of a wide variety of breeds that supply the Fair Trade and Slow Food regional markets. Some of these local breeding companies and associations require support, including at the regional level, from donor institutions and/or national governments in order to survive. Such subsidies are part of the International Initiative on Farm Animal Genetic Resources (IIAnGR), established in 2014.

IIAnGR was established to enhance a wide range of national initiatives to support the conservation and sustainable use of farm animal genetic diversity. However, the gradual development of the market into two segments (globalised and national/regional) has not resulted in an increase in the international exchange of genetic resources. BPAIC is entirely self-contained in terms of genetic resources and provides the commercial sector with excellent breeding stock; national breeding programs exchange genetic material within the region but the national breed activities tend to avoid the use of exotic materials. Access to genetic resources and benefit sharing issues on a global level have thus become less relevant than expected.

## 2050 Biotechnology scenario

### *Driving forces*

A series of developments in biotechnology are expected to speed up on-going developments in the livestock sector with potentially major impacts on the exchange, use and conservation of AnGR through:

- Continued progress in reproductive and cryopreservation technologies for all livestock species.
- Development of a new generation of quantitative genetic tools, linking genomics and quantitative genetics.
- Improved efficiency and safety of transgenic and cloning technologies.
- Better control of animal diseases and increased availability of (marker) vaccines.

Based on the impact of a combination of these major breakthroughs by 2050, it may be expected that superior genotypes will be distributed and



used across the globe even more easily than today, which may negatively affect the conservation of global farm animal genetic diversity. Furthermore, rapid developments in biotechnology are providing new opportunities to explore and possibly exploit genetic resources in ways that were not possible before. Exchange patterns may change and AnGR from developing countries may increasingly contribute to commercial breeding. Molecular biology is already having an increasing impact on the animal breeding sector, as well as playing a role in the introduction of the patenting of processes and products used in animal breeding.

### *The 2050 Scenario*

All continents have recovered from a serious global recession, which surprisingly did not stop scientists continuing to develop (bio)technology. After a relatively quiet period, investors are seriously interested again in the implementation of biotechnologies in their businesses. Last week, Clonestock, a world leading biotech company, which has undertaken two major acquisitions in the livestock breeding sector, organised a press conference, which attracted a lot of attention in the international agricultural press. Stock prices of Clonestock have increased by 20% today.

The press release showed the final, positive results of safety studies of genetically modified clones of Robusta cattle. The company managed to produce a highly productive breed with specific heat and disease tolerance characteristics. The original breed was genetically modified, introducing a selected number of genes, after many years of studying the genetic background of heat and disease resistance. The company patented many genes with major and/or minor effects. This selection was greatly assisted by the development of effective cloning techniques developed in the early 21<sup>st</sup> century.

The introduction of Robusta cattle had already started in 2025 and at that time Clonestock had set up a nucleus herd with the aim of selecting the best Robusta sires and dams to produce commercial offspring. Clonestock started selling clones of the best combinations of sires and dams to commercial dairy farms all over the world, especially to less favoured areas or those in tropical climates. Clonestock predicts that by the end of this year (2050), 25% of dairy production in Asia, Africa and the Americas will be produced by their clones.

In the late 20<sup>th</sup> century breeding and biotech companies did not invest in transgenic and cloning

technologies, because of negative consumer perceptions and ethical considerations. Scientists had also serious doubts about the safety of these technologies in farm animals and about animal health and welfare implications. However, public perception changed slowly when GMO crops proved to be safe and when on-going research in this area showed that it was possible to produce transgenics and clones on a large scale.

Clonestock strategically decided to combine cloning with the production of transgenic animals. Within this context the company was better able to protect breeding stock and property rights in relatively small nucleus herds. Cloning of transgenic animals appeared to be a safe and efficient way of disseminating breeding animals or embryos for production purposes. In order to protect their investments in research and breeding, Clonestock introduced a 'termination' gene into the cloned genetic material, which made it impossible for the clones to reproduce.

The introduction of cloned transgenic animals does not affect smallholders directly. Poor countries and small holders can continue to breed and keep their local breeds but the production gap between the clones and the local animals is further increasing. To some extent this will affect local markets and local communities, because prices of animal products, including animal products produced by clones, are expected to drop even further.

Although policy makers and scientists argued that plant genetic resources and plant breeding raise totally different issues from those associated with animal genetic resources and animal breeding, *ex-situ* conservation differences between plants and animals disappeared to a large extent as a result of rapid developments in biotechnology. After the International Technical Conference on AnGR in 2007, the international community and larger biotech and breeding companies decided to develop global and private gene bank initiatives. Private companies invested in cryo-preservation of germplasm and somatic cells for strategic reasons. The international community decided to start an emergency cryo-preservation programme and develop a trust fund after another outbreak of foot and mouth disease in Asia in 2007. Access to the global gene bank is possible under a strict Material Transfer Agreement which includes a provision that benefits arising from the use of gene bank material have to flow back to the trust fund. Because of this strict rule, breeding and biotech companies decided to set up an insurance cryo-preservation collection themselves and to put more emphasis on

maintenance of within breed/line/company diversity.

## 2050 Climate change & environmental degradation scenario

### *Driving forces*

Known causes or drivers of past climate change include changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation and in land surface properties. Such changes can have both manmade (e.g., greenhouse gas emissions, land use changes) and natural (e.g., volcanic emissions, changes in the Earth's orbit, changes in the sun's intensity) origins. Five main impacts on global climates can be identified in terms of temperature, precipitation, sea level rise, the incidence of extreme weather events, and the level of atmospheric carbon dioxide and other greenhouse gas content. Climate change can be expected to affect livestock productivity directly by influencing the balance between heat dissipation and heat production and indirectly through its effect on the availability of feed, fodder and water, as well as changes in disease challenge. Among other possible effects, climate change may significantly move livestock production away from current marginal rangelands, and may thus contribute to the shift in favour of intensive production systems.

### *The 2050 Scenario*

By 2050 Earth's now more affluent human population has increased from the 6.5 billion in 2005 to 9 billion, over 65% of whom live in cities. Global mean surface temperatures have risen by 2°C compared to 1990 and mean sea levels have risen by 25 cm. Global mean precipitation is 2% higher than in 1990. However, these global numbers hide complex spatial patterns of changes. In some regions, temperature increases are three times the global mean, while in others temperatures have declined.

The specific direction of change can only be predicted by considering specific localities. Broadly speaking at the higher latitudes (beyond 50°N and 50°S), higher temperatures have lengthened and increased the intensity of the growing season. Crop and feed yields have increased in those regions

where there have been no major changes in rainfall. By contrast, in tropical and equatorial regions higher temperatures since 2005 have further exacerbated what had already been quite frequent water and heat stress on plants due to higher rates of evaporation. In addition, changes in extreme weather and climatic events have occurred increasing livestock losses, decreasing yield stability, damaging production infrastructure and disrupting access to markets. Environmental degradation has accompanied these processes, which has caused a drop in crop and livestock levels. The unequal distribution of losses and gains has had a major effect on production, trade and relative prices.

The fact that the speed of climate change has been and will continue to be faster than the speed of livestock and forage evolutionary adaptation means that many of the breeds used in extensive systems have moved or been replaced. Large-scale movement of livestock breeds occurred in search of more appropriate climatic zones (e.g., lowland sheep can now be found in the highlands) and less degraded pastures. By contrast hardy wildlife species, such as the Oryx, have increasingly been domesticated for use in areas of high climatic challenge.

Although the direct impact of climate change on livestock systems has only been moderate in global terms, it is expected to increase in severity and consequently all nations are strongly behind the 2027 'Son of Kyoto' protocol and its greenhouse gasses (GHGs) trading mechanisms, which include methane emitted from livestock.

The growing volume of livestock trade has resulted in AnGR research becoming more important. Increased germplasm flows within and between countries create new opportunities for crossbreeding and the introduction of exotics, together with a need to ensure that such flows are beneficial and do not threaten remaining livestock diversity. Genetic impact assessments and controlled breeding programmes play a key role in this context. Research related to the economic benefits of livestock germplasm flows have also been important, ensuring that such germplasm flows continue to facilitate monetary and non-monetary benefit sharing. Internationally funded AnGR research is now comparable to that of crops and plants, compared to being less than 10% in 2005.

## 2050 Disease & disaster scenario

### *Driving forces*

International trade and human travel has already led to the rapid spread and ultimately the globalization of diseases, resulting in a deterioration in the global animal health situation during 1980-2000. This situation is expected to worsen. Diseases, natural disasters, civil war and other threats can have a serious impact on local AnGR and thus on conservation of global farm animal genetic diversity.

### *The 2050 Scenario*

The ripah-virus disease which affects pigs has now arrived in southern Africa. Starting in eastern Asia in April 2042, it was able to conquer almost half the globe in less than 5 years. This paramyxovirus used to be a harmless virus that lived in the hindgut and was originally excreted and decomposed in manure. However, the feeding of manure to animals had become a necessity in the 2030s in order to keep up with the increasing meat demand of the world population which has become more affluent than ever projected. Despite the many safety regulations for heat treatment of the manure the ecology of the hindgut changed, with the virus developing heat resistance and increasing virulence.

Following the outbreak of a fast-spreading poultry disease named avian influenza in the early 2000s, researchers and international organizations had already warned that the high density of various domestic animals species and humans in the emerging intensive production systems, particularly in Asia, may lead to increased disease risks in farm animals and humans.

Today, in hot summer weather, the ripah-virus experiences optimal conditions and spreads fast. Veterinary and medical services all over the world are collaborating in their efforts to fight the disease which has already seen 10 million pigs killed by severe diarrhoea and respiratory problems. Stamping the virus out through mass pig culling is the preferred control strategy, but breeders of local breeds are scared about the potential loss of their breeding stock. Culling is likely to particularly affect those breeds that are not registered in herd books, as registration in a herd book is required to receive the exemption permit given by the Global Animal Breed Conservation Trust. Breed registration also offers an entry point for semen or somatic cell storage in the trust's (*ex-situ / in-vitro*) gene bank. However, there

are many breeds for which breeds associations or herd books do not exist. These were bred either by local communities or commercial companies who had various reasons for not registering their breeds. For example, some communities had instead chosen to include their breeds in local/indigenous breed registers, whereas companies had chosen to register the products of their breeds as trademarks.

An international gene bank had become necessary after the value of breeds was internationally recognized as our global heritage and a back-up system for future restocking was considered necessary. As many countries recognized that they did not have the capacity to have their own secure gene bank, they decided to establish an international gene bank, with the necessary regulatory framework to enable the exchange of material to and from this gene bank. The international gene bank developed standard forms for Prior Informed Consent, Material Acquisition Agreements and Material Transfer Agreements for receiving and passing-on material, in agreement with the owners.

Material from the gene bank had already been used for restocking after the disastrous earthquake in Indonesia which caused the loss of most animals. Since its establishment in 2010, the gene bank has built up a collection that covers 40% of all breeds of domestic animal species across the globe. All material is cryo-preserved in liquid nitrogen. Breeds from the developed countries are much better represented in the gene bank, because it was easier for these countries to provide some back-up material from their normal breeding activities. As artificial insemination was less practised in developing countries in the early days, their breeds have been stored less frequently. However, recent years have seen more somatic cells from developing country breeds being deposited, as they can be easily collected through a biopsy in the ear.

At the present time, the ripah-virus threat has triggered rare breed and animal welfare NGOs to establish breed rescue teams which collect genetic material in the affected countries, in collaboration with the veterinary services. The geo-referenced database held by the trust helps to locate breeds in remote areas, and the Material Acquisition Agreements are simple and can be used even within the short time available in such emergency situations. These teams had managed to save the genetic material of a further 42 breeds in 20 countries before the disease hit, and thus saved our global biodiversity heritage for future use.

## Stakeholder Consultation

Having developed the scenarios, they were then used as an input into the stakeholder consultations. A wide range of stakeholder group representatives (e.g., government officials, scientists in the public and private sectors, representatives of breeding organisations and livestock keepers or representatives of their organizations) were consulted through:

- interviews in four case study countries (Brazil, Ethiopia, India, the Netherlands)<sup>7</sup>.
- additional interviews in other OECD, African, Asian and Latin American countries.
- an e-conference involving approximately 200 participants from 43 countries<sup>8</sup>.

## Stakeholder perspectives and findings

### *Globalization*

A large majority of stakeholders believes that the current globalization trend will continue. Globalization will bring considerable uniformity in animal products. Current niche products could become global, and uniformity will lead to the dominance of fewer breeds. Although one interviewee indicated that the dominance of a small number of breeds would not necessarily result in a decrease of global genetic diversity, the majority of interviewees believe that uniform, intensive production systems (in family owned or corporate farms) with the same breeds all over the world will have a strong negative effect on indigenous breeds. Therefore it would be necessary to strengthen conservation strategies for local/indigenous breeds and to create gene repositories.

There was also a strong belief in the potential for the development of regionalized and niche markets based on livestock products. Much will depend on the viability of local or regional markets and

products. The trend towards special products is currently mainly localized in Europe but stakeholders from other regions also have a positive view on the development of niche products or local markets.

Although there was generally agreement that universalized demands and concepts could be beneficial for the development of niche or local markets, in general globalization was seen as a potential constraint to the development of local food systems and the use of local breeds for food production. Retailers and supermarkets will be playing a lead role in the globalization process. Vertical integration is expected to become the primary business model on a global scale. Small farmers and local breeds will have problems to meet the requirements for food safety and product uniformity, and compete in global markets with corporate or large scale operations with vertically integrated enterprises. Developments in agriculture taking place in developed countries are expected to be repeated in other parts of the world but local consumer demands in developing countries may not be strong enough to sustain specialty products.

Current trends towards uniform production systems, the standardization of consumer products and a move towards large scale production are expected to continue. In this respect, developing countries become increasingly dependent on developed countries providing the resources or products and they may not benefit much from globalization. Some stakeholders noted that unequal conditions in relation to the ability to cope with globalization would result in developing countries continually lagging behind richer countries, as the latter have technologies and capital resources that are absent in poorer countries.

It is also expected that globalization will result in the degradation of ecosystems and ecosystem services which poor people depend upon for their survival.

Different views were expressed by NGO and farmers' representatives with regard to the

<sup>7</sup> Countries were selected on the basis of their representing different development categories, the importance of the livestock sector within those countries, the existence of different types of production systems and producer sizes, varied genetic resource policy and/or legal approaches, different degrees of biotechnology capacity and different vulnerability to climate change or disasters.

<sup>8</sup> It is acknowledged that the number of case study countries was limited and e-conference participation and additional stakeholder interviews in non-case study countries do not cover the entire world. Consequently, some important viewpoints and specific situations may have not been covered. However, within the time and funding constraints of the FAO commissioned report, a range of country types were selected and a wide range of stakeholders consulted, with the goal of permitting a balanced analysis that can support informed decision-making with regard to policy and regulatory options for AnGR.

strategies to cope with globalization, i.e. whether the focus should be on improving competitiveness (farmers), or on the protection of local producers from the impact of globalization (e.g., imports of competing goods) and from the expanding vertical integration within the livestock production and marketing sectors (NGOs). Some farmers viewed globalization as advantageous in terms of increasing market opportunities, but expect the government to address issues related to animal health.

It was also suggested that national governments should mainly focus on development of rural areas and of associated animal genetic diversity and livelihoods, because rural development is (compared to peri-urban developments) less attractive for the private sector and therefore lacks investment. The challenge is to support livestock development and to protect pastoralists, smallholders and their breeds at the same time.

### *Biotechnology*

Reproductive technologies have revolutionized the animal breeding sector and facilitated the exchange of genetic material between countries and regions of the world. However, scientists are as yet unclear about whether the technologies currently available or in the pipeline will find a practical application in the foreseeable future. Some claim that some of these technologies which are already in use or will become available for animal breeding, could have serious impacts on the characteristics and structure of animal breeding. Indian stakeholders argued that if investments become available for identifying the genes for disease resistance, adaptability, fertility and growth, the leadership of animal industries will shift to developing countries that have dense and diverse populations of AnGR.

Breeders and the breeding industry realize that biotechnology has led to reduced genetic variability, mainly through widespread multiplication of individuals. Such a trend may be extrapolated when new techniques become available and when the concentration in the breeding industry for cattle, pigs and poultry further increases. Breeders in the Netherlands generally think that consumer pressure may reduce the impact of new biotechnological developments, such as genetic modification or cloning, on developments in the breeding industry. Cloning is expected to be viewed slightly more favourably than genetic transformation (GM animals).

Government representatives were less concerned about biotechnology issues than other stakeholders. Some consider that despite the current restrictive nature of the regulations on these technologies, the application of biotechnology in breeding and production cannot be stopped in the long run. However, they also realize that animals are much more complex organisms than plants in terms of reproduction control, and such complexity will reduce the speed of application of biotechnology.

A number of stakeholders cautioned about serious ethical problems and potential conflicts between the breeding industry and farmers. Important issues are 'food safety' or 'squeezing poor countries out of animal production'. Some claim that the major beneficiaries of biotechnology applications will be the resource rich stakeholders. Poorer countries and poor livestock farmers within these countries are likely to lose out. Biotechnology developments will also trigger further discussions about benefit sharing arrangements and intellectual property rights. Several respondents felt they were insufficiently informed about a range of biotechnology developments and issues.

Biotechnology is also considered to be potentially increasingly important for the conservation, evaluation and utilization of AnGR. However, advanced (reproductive) technologies are not frequently used for local breeds (in developing countries). Several biotech developments have been much more slowly implemented than originally predicted. Others stated that those technologies are particularly well suited to further develop local breeds and that insight into resistance to diseases and abiotic stresses may even help to increase leadership in animal breeding in developing countries. Hence, the impact of biotechnology may be either positive or negative depending on how it is used or regulated.

### *Climate change*

A majority of stakeholders involved in this study could envision that climate change may have a serious impact on the exchange, use and conservation of AnGR. Stakeholders in India and Ethiopia were particularly outspoken on this topic and mentioned climate and environmental change as one of the major future driving factors.

According to government representatives, when climate is changing drastically, the adaptability of breeds will become more critical. Climate change could result in rapid and significant changes in livestock systems and their dynamics. Such a

scenario underlines the mutual dependency of countries in genetic resources. The main effect of climate change is expected to be seen in extensive livestock systems.

Breeders on the other hand stated that modern/science based breeding will go faster than climate change and can be handled by breeding companies. They realize that it will require faster adaptation of breeds than today to be able to serve a variety of production systems. A prevalence of (new) diseases might however complicate the breeding of adapted breeds.

Scientists argued that climate change will affect livestock systems mainly by the effects of a prevalence of diseases, but also that, for example, animals from lowland areas may replace those in the cooler highlands. Some think that climate change will lead to more frequent drought but this may affect population sizes rather than AnGR diversity *per se*. In this respect we can learn from current restocking programmes after drought<sup>9</sup>. Conservation of AnGR may become a major issue when we realize that both crossbreds and traditional breeds could be lost due to a lack of suitable environmental conditions.

Livestock keepers consider that the effect of climate change will be more positive than negative or are not aware of any significant change in climate. One interesting dilemma here is whether climate change will go faster than adaptation capacity of breeds or breeding programmes. A pastoralist said that effects may be less than mentioned in the scenario.

### *Diseases and disasters*

Some case study countries have recently faced problems as a result of outbreaks of animal diseases. In the Netherlands and Brazil, such diseases were a threat to unique farm animal populations and seriously affected the export of animal products. On the other hand, in the Netherlands and the UK, recent disease outbreaks resulted in an increased interest in (conservation of) farm animal genetic diversity.

Dutch government representatives said that very strict veterinary regulations are needed and (harmonisation of) veterinary issues should play a

more prominent role in WTO. Others expect that stricter zoo-sanitary regulations will operate as non-tariff trade barriers. Some scientists claim that this might strengthen the utilization of locally adapted breeds, due to their tolerance/resistance to diseases and parasites.

Some southern stakeholders seek a solution in disease free-zones that could form part of a '*fair trade*' framework, while others thought that this would be difficult to implement and may create an additional trade barrier. It was also argued that such disease free zones might work against the need for the free movement of livestock keepers, particularly in pastoral areas.

Many contributors underlined the threat of diseases and disasters and the impact of disease eradication programmes on local/indigenous breeds. However, evidence on such impact is limited. It is important to anticipate these serious threats and conserve animal genetic diversity through various strategies. Several contributions indicated that we need national, regional and global systems for monitoring and conservation of important AnGR.

## Discussion and Potential Policy Instruments

A majority of stakeholders considered that all four scenarios might become a reality in one way or another and may affect the exchange, use and conservation of AnGR. A general conclusion from the overall consideration of the scenarios by stakeholders was that although (perceived) short term problems are limited, substantial longer term effects on exchange, use and conservation may arise in the future. Exchange may increase or exchange patterns may change, together with changes in (intellectual) property rights protection and an increasing imbalance in the power relationships between rich and poor (both between and within countries). Interviewees were most outspoken about the need for the strengthening of an AnGR regulatory framework in the context of the biotechnology scenario, which particularly raised equity issues.

---

<sup>9</sup>Author's comment: note that a number of restocking programmes to date have had a negative effect on AnGR diversity due to restocking with other than local breeds.

The on-going globalization process is certainly seen as having the potential to affect exchange patterns and negatively affect the conservation of farm animal genetic diversity. The effects of biotechnology and climate change were generally considered as of concern only over a longer term horizon. While both were considered to have rather unpredictable impacts, they have the potential to have a significant effect on the exchange, use and conservation of farm animal genetic diversity, including a positive effect on conservation or development of adapted breeds. Diseases and disasters are also unpredictable but it is clear that they could seriously threaten AnGR if such a scenario becomes a reality.

A range of potential policy instruments could be applied to address the stakeholder concerns identified in the consultation process. Any policy instruments targeted to improve AnGR management should ensure that the measures:

- Generate benefits to the economy, environment, or society under current conditions.
- Address high-priority issues such as irreversible impacts of the loss of animal biodiversity, long-term planning for adaptation (e.g., breeding), and unfavourable trends (e.g., breed replacement) which may inhibit future adaptive management.
- Target current areas of opportunity (e.g., revision of national livestock sector development plans or breeding laws; research and development).
- Are feasible (adoption is not significantly constrained by institutional, social/cultural, financial, or technological barriers).
- Are consistent with, or even complementary to, adaptation or mitigation efforts in other sectors [see IPCC (2001, Section 18.4.2)].

Many of the possible policies have been discussed at a number of international meetings<sup>10</sup> and it is also interesting to note how some of them cut across the different scenarios. In summary, the potential (non-comprehensive) range of instruments includes<sup>11</sup>:

- Support for both the conservation and improvement of local AnGR. Provide financial incentives for breeding and raising local breeds and promote/support marketing of local breed products.

- Capacity building (education, awareness raising, information, use of participatory approaches, recognition of importance of AnGR, etc.)
- Regulation of export and import of livestock germplasm, establishing protocols for the guidance of donors and NGOs when importing exotic breeds, including through the development and implementation of 'genetic impact assessments'. Protocols could also play a role in the promotion and adoption of 'AnGR-friendly' restocking programmes following disasters such as droughts or diseases. Furthermore, national Biosafety Acts could be established within which any future introduction of AnGR containing genetically modified organisms can be regulated.
- Ensure greater levels of effectiveness in the surveillance and monitoring of infectious diseases in humans, wildlife, and livestock. Clear policy mandates must be put in place to encourage and ensure the rapid worldwide sharing and dissemination of information on infectious disease outbreaks. Adoption of increasingly demanding international sanitary standards drawing on international codes and standards from the Organisation Internationale des Épizooties (OIE) and Codex Alimentarius. Make special provisions for indigenous AnGR in animal disease acts.
- Address potential smallholder exclusion by building participatory institutions of collective action for small-scale farmers that allow them to be vertically integrated with livestock processors and input suppliers. Provide additional support to smallholders through:
  - a. market reform policies that encourage smallholder investment and avoid differential subsidies to large-scale operations
  - b. institutional development to help small-scale operators meet global standards regarding quality, food safety, and timeliness (including in the context of supermarkets' procurement systems); and
  - c. the provision of public goods such as research, extension, and infrastructure.

<sup>10</sup>In particular, "Community-based Management of Farm AnGR", Mbabane, 2001; "Incentive Measures for Sustainable Use and Conservation of Agro-biodiversity", Lusaka, 2001; "Development of Regional and National Policy"; Luanda, 2002; and "Legal and Regulatory Framework for Farm AnGR", Maputo 2003. For full details, see Koehler-Rollefson (2004).

<sup>11</sup>Further details regarding the development of this list of policy options can be found in Hiemstra *et al.* (2006), as well as in Hiemstra *et al.* (this issue).

- Acknowledge the critical role that local communities play in AnGR conservation, and secure access rights to natural resources for indigenous livestock breeding communities (could include 'Karen Declaration'-type of livestock-keepers rights approach which includes support for indigenous knowledge remaining in the public domain and that AnGR be excluded from intellectual property rights claims; regime for research and development).
- Develop procedures for access and benefit sharing, including Prior Informed Consent (based on the recommendations of the Bonn Guidelines), and possibly within a framework similar to that of the African Model Law.
- Inclusion of livestock under any future emissions trading schemes (e.g., under 'Son of Kyoto')

## Conclusions

Returning back to the present from our exploration of the future in 2050, it appears that embarking on such time travel has been very useful in helping to think in terms of current problems, on the one hand, and a situation 40+ years from now, on the other hand. The 'far' future perspective appeared to make people less defensive, especially in a situation where current exchange problems were not particularly visible or well documented (as of yet). Many interviewees broadly considered that it was not a question of 'if' the scenarios would happen, but rather a question of 'when'. This implies that we might do well to consider the need to respond to future challenges through the proactive development of new policies or regulations. Such a finding is partly in contrast with many participants' general perception of the current regulatory situation being broadly acceptable.

With regard to the above list of potential policy options that follows logically from the scenario development process and the findings of the stakeholder consultation, it should be noted that the authors simply present these as a list of options which, together with others, could form the basis for informing future debate about the need for such policy and regulatory options. The task of deciding which, if any, of these options to adopt and the form in which they may be adopted, falls to the decision-makers who are one of the main target audiences of this paper and the original Hiemstra *et al.* (2006) study.

## Acknowledgements

We are grateful to FAO for commissioning this study, and to the Government of the United Kingdom of Great Britain and Northern Ireland for funding it through the Department for International Development DFID.

## List of References

### General

**Almekinders, C.M.J.** 2002. Incentive measures for sustainable use and conservation of agrobiodiversity. Experiences and lessons from Southern Africa. Proceedings of a workshop, Lusaka, Zambia, 11-14 September 2001, pp. 175.

**FAO.** 2003. Community based management of animal genetic resources. Proceedings of the workshop held in Mbabane, Swaziland, 7-11 May 2001, pp. 180.

**Hiemstra, S.J., A.G. Drucker, M.W Tvedt, N. Louwaars, J.K. Oldenbroek, K. Awgichew, S. Abegaz Kebede., P.N. Bhat & A. da Silva Mariante.** 2006. Exchange, use and conservation of animal genetic resources: policy and regulatory options. Report 2006/06. Centre for Genetic Resources, the Netherlands (CGN), Wageningen University and Research Centre, the Netherlands. [www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice](http://www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice).

**Koehler-Rollefson, I.** 2004. Farm animal genetic resources - Safeguarding national assets for food security and trade. Summary of four Workshops held in the Southern African Development Community. GTZ/BMZ/FAO/SADC/CTA. Eschborn.

### Globalization and regionalisation

**Delgado, C., N. Minot & N. Wada.** 2001. High value agriculture: shaping globalization for poverty alleviation and food security. IFPRI 2020 Focus 8 (Shaping Globalization for Poverty Alleviation and Food Security), August. Washington D.C. USA.



- Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui & C. Courbois.** 1999. Livestock to 2020 - The next food revolution; Food, Agriculture, and the Environment Discussion Paper 28, FAO. Rome, [www.fao.org/ag/againfo/resources/documents/lvst2020/20201.pdf](http://www.fao.org/ag/againfo/resources/documents/lvst2020/20201.pdf).
- Delgado, C.L. & C. Narrod.** 2002. Impact of changing market forces and policies on structural change in the livestock industries of selected fast-growing developing countries. Final Research Report of Phase I - Project on Livestock Industrialization, Trade and Social-Health-Environment Impacts in Developing Countries, FAO, [www.fao.org/WAIRDOCS/LEAD/X6115E/x6115e00.htm#Contents](http://www.fao.org/WAIRDOCS/LEAD/X6115E/x6115e00.htm#Contents)
- Dirven, M.** 2001. Dairy clusters in Latin America in the context of globalization. *International Food and Agribusiness Management Review* 2(3/4): 301-313.
- Dudley, J.** 2004. Global zoonotic disease surveillance: an emerging public health and biosecurity imperative. *BioScience* Vol 54 (11) pp.982-983, Washington D.C.
- FAO.** 1997. Long-Term Scenarios of Livestock-Crop-Land Use Interactions in Developing Countries. FAO Land and water bulletin 6. Rome, Italy
- FAO.** 2005. The Globalizing Livestock Sector: Impact of Changing Markets. 19<sup>th</sup> COAG, April 2005, Rome, <ftp://ftp.fao.org/unfao/bodies/coag/coag19/j4196e.doc>
- FAO.** 2007. Managing Livestock - Environment Interactions. 20<sup>th</sup> COAG, April 2007, <ftp://ftp.fao.org/docrep/fao/meeting/011/j9421e.pdf>
- Gill, M.** 1999. Meat production in developing countries. Proceedings of the nutrition society. Vol. 58 (2). Natural Resources International Ltd., Chatham Maritime, UK.
- Hobbs, J. & W. Kerr.** 1998. Structural Developments in the Canadian Livestock Subsector: Strategic Positioning Within the Continental Market. In R.M.A. Loyns, *et al.* (Eds), Proceedings of the Fourth Agricultural and Food Policy Systems Information Workshop, Economic Harmonization in the Canadian/U.S./ Mexican Grain-Livestock Subsector. University of Guelph and Texas A&M University, pp. 125-143.
- Kouba, V.** 2003. Globalization of communicable diseases and international trade. Proceedings of the 10<sup>th</sup> international symposium for veterinary epidemiology and economics. Vina del Mar, Chile.
- Nin Pratt, A., L. Lapar & S. Ehui.** 2003. Globalization, trade liberalization and poverty alleviation in Southeast Asia: the case of the livestock sector in Vietnam. 6<sup>th</sup> annual conference on global economic analysis, Scheneningen, The Hague, Netherlands.
- Popkin, B. & S. Duy.** 2003. Dynamics of the nutritional transition toward the animal foods sector in China and its implications. The American Society for Nutritional Sciences, *Journal of Nutrition*.
- UN Population Division.** 2003 and 2004, <http://esa.un.org/unpp>
- Vinkyl, N. & T. Kleynhans.** 2002. Trade liberalization, the livestock revolution and the impact on South African rangelands. University of Stellenbosch, South Africa.
- Weatherspoon, D. & T. Reardon.** 2003. The rise of supermarkets in Africa: implications for agrifood systems and the rural poor. *Development Policy Review* Vol. 21 pp. 333-355. Michigan State University, USA.

## Biotechnology

- AEBC.** 2002. Animals and Biotechnology. A report by the AEBC. Agriculture and Environment Biotechnology Commission. September 2002.
- Andersson, L & M. Georges.** 2004. Domestic animal genomics: deciphering the genetics of complex traits. *Nature Reviews Genetics*. Volume 5, March 2004.
- European Commission.** 2003. Genomics Research in Livestock, What does it offer? EUR: 21031.
- Gibson, J.P. & S.V. Pullin.** 2005. Conservation of Livestock and Fish Genetic Resources. Science Council Secretariat, FAO.
- Hiemstra, S.J., T. van der Lende & H. Woelders.** 2005. The potential of cryopreservation and reproductive technologies for

animal genetic resources conservation strategies. Proceedings, Workshop on Biotechnology and Conservation, Turin, Italy, March, 2005

**Hoffmann, I. & B. Scherf.** 2005. Management of farm animal genetic diversity: opportunities and challenges. WAAP Book of the Year 2005, pp. 221-245.

**Makkar, H.P.S. & G.J. Viljoen (Eds).** 2005. Applications of gene-based technologies for improving animal production and health in developing countries, The Netherlands, Springer.

**Meuwissen, T.H.E.** 2005. Use of genomic information for genetic improvement of livestock. Proceeding of the Annual Meeting of the European Association for Animal Production, Uppsala, Sweden, 5-8 June 2005.

**Boa-Amponsem, K. & G. Minozzi.** 2006. The state of development of biotechnologies as they relate to the management of animal genetic resources and their potential application in developing countries. Background Study Paper no. 33. Rome, FAO, <ftp://ftp.fao.org/ag/cgrfa/BSP/bsp33e.pdf>

**Rothschild, M.F., G. Plastow & C. Newman.** 2003. Patenting in animal breeding and genetics. WAAP Book of the Year 2003, pp, 269-278.

## Climate change and environmental degradation

**Anderson, S.** 2004. Environmental effects on animal genetic resources. Background Study Paper 28, Rome, FAO, <ftp://ftp.fao.org/ag/cgrfa/BSP/bsp28e.pdf>.

**AGO (Australian Greenhouse Office).** 2004. Agricultural Impacts and Adaption) Department of the Environment and Heritage, Australian Government, <http://www.greenhouse.gov.au/impacts/agriculture.html>.

**ABS (Austalian Bureau of Statistics).** 2004. Measures of Austalias Progress. [www.abs.gov.au/Ausstats/abs@.nsf/0/d994d50fc56e79e3ca256e7d0000264e?OpenDocument](http://www.abs.gov.au/Ausstats/abs@.nsf/0/d994d50fc56e79e3ca256e7d0000264e?OpenDocument).

**CCAA (Climate Change and Agriculture in Africa).** 2002. Facts about Africa Agriculture Climate. [http://www.ceepa.co.za/climate\\_change/index.html](http://www.ceepa.co.za/climate_change/index.html)

**Charron, D.** 2002. Potential impacts of global warming and climate change on the epidemiology of zoonotic diseases in Canada. Canadian Journal of Public Health. [www.findarticles.com/p/articles/mi\\_qa3844/is\\_200209/ai\\_n9132821#continue](http://www.findarticles.com/p/articles/mi_qa3844/is_200209/ai_n9132821#continue)

**FAO.** 2004. Impact of climate change on agriculture in Asia. 27<sup>th</sup> FAO Regional Conference for Asia and the Pacific. Beijing, China, 17-21 May. APRC/04/INF/9. Rome.

**FAO.** 2006. Breed diversity in dryland ecosystems. Information document no. 9, [www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/CGRFA-WG-AnGR-4-06-inf9.pdf](http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/CGRFA-WG-AnGR-4-06-inf9.pdf)

**FAO.** No date. Extensive pastoral livestock systems: issues and options for the future. [www.fao-kyokai.or.jp/edocuments/document2.html](http://www.fao-kyokai.or.jp/edocuments/document2.html)

**Frank, K., T. Mader, J. Harrington & G. Hahn.** No date. Potential Climate Change Effects on Warm-Season Livestock Production in the Great Plains. Journal Series no. 14462, Agric. Res. Div., University of Nebraska.

**MAFF (Ministry of Agriculture, Food and Fisheries).** 2000. Climate Change and Agriculture in the United Kingdom. [www.defra.gov.uk/environ/climate/climatechange/index.htm](http://www.defra.gov.uk/environ/climate/climatechange/index.htm).

**IPCC (International Panel on Climate Change).** 2001. Climate change 2001: impacts, adaptation, and vulnerability. CUP.

**Kenny, G.** 2001. Climate Change: Likely Impacts on New Zealand Agriculture: A report prepared for the Ministry for the Environment as part of the New Zealand Climate Change Programme.

**Kristjanson, P.M., P.K. Thornton, R.L. Kruska, R.S. Reid, N. Henninger, T.O. Williams, S. Tarawali, J. Niesen & P. Hiernaux.** 2001. Mapping livestock systems and changes to 2050: implications for West Africa. Sustainable crop-livestock production for improved livelihoods and natural resource management in West Africa. Proceedings of an international conference.

**Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales & C. de Haan.** 2006. Livestock's long shadows. Environmental issues and options. FAO, [www.virtualcentre.org/en/library/key\\_pub/longshad/A0701E00.pdf](http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf) .

**Tisdell, C.** 2003. Socioeconomic causes of loss of animal diversity genetic: analysis and assessment. *Ecological Economics* 45 (3), 365-376.

**UN Population Division.** 2003 and 2004. <http://esa.un.org/unpp>.

**WRI (World Resources Institute).** 2000. Pilot Analysis of Global Ecosystems: Agroecosystems.

## Disease and disasters

**Charron, D.** 2002. Potential impacts of global warming and climate change on the epidemiology of zoonotic diseases in Canada. *Canadian Journal of Public Health*. [www.findarticles.com/p/articles/mi\\_qa3844/is\\_200209/ai\\_n9132821#continue](http://www.findarticles.com/p/articles/mi_qa3844/is_200209/ai_n9132821#continue).

**Heffernan, C. & M.R. Goe.** 2006. The impact of disasters and emergencies on animal genetic resources. Rome, FAO, Background Study Paper no. 32 <ftp://ftp.fao.org/ag/cgrfa/BSP/bsp32e.pdf>.

**Ingressia, A., D. Manzella & E. Martyniuk.** 2005. The legal framework for the management of animal genetic resources. FAO Legislative Study 89. ISSN 1014-6679. ISBN 92-5-105433-9, Rome.

**Kouba, V.** 2003. Globalization of communicable diseases and international trade. Proceedings of the 10<sup>th</sup> international symposium for veterinary epidemiology and economics. Viña del Mar, Chile.

**McDermott, J., P. Coleman & T. Randolph.** 2001. Methods for assessing the impact of infectious diseases of livestock - their role in improving the control of Newcastle disease in Southern Africa. Alders, R.G. & Spradbrow, P.B. (Eds). Australian Centre for International Agricultural Research, Canberra. SADC planning workshop on Newcastle disease control in village chickens. Proceedings of an international conference. ACIAR Proceedings. no.103. p. 118-126. Canberra (Australia): ACIAR.

**McLeod, A., N. Morgan, A. Prakash, & J. Hinrichs.** 2005. Economic and social impacts of Avian Influenza, FAO, [www.fao.org/ag/againfo/resources/en/pubs\\_ah.html#4](http://www.fao.org/ag/againfo/resources/en/pubs_ah.html#4).

**Otte, J. et al.** 2004. Transboundary Animal Diseases: Assessment of socio-economic impacts and institutional responses Livestock Policy Discussion paper no, 9, [www.fao.org/ag/againfo/resources/en/publications/sector\\_discuss/PP\\_Nr9\\_Final.pdf](http://www.fao.org/ag/againfo/resources/en/publications/sector_discuss/PP_Nr9_Final.pdf).

**Springbett, A.J., K. MacKenzie, J.A. Woolliams & S.C. Bishop.** 2003. The contribution of genetic diversity to the spread of infectious diseases in livestock populations. *Genetics*, 165(3): 1465-1474.



# Regulatory options for exchange, use and conservation of animal genetic resources: a closer look at property right issues<sup>1</sup>

M.W. Tvedt<sup>1</sup>, S.J. Hiemstra<sup>2</sup>, A.G. Drucker<sup>3</sup>, N. Louwaars<sup>2</sup> & J.K. Oldenbroek<sup>2</sup>

<sup>1</sup>The Fridtjof Nansen Institute, P.O. Box 1326, N-1326 Lysaker, Norway

<sup>2</sup>Centre for Genetic Resources (CGN), Wageningen University and Research Centre, Wageningen, The Netherlands

<sup>3</sup>School for Environmental Research, Institute of Advanced Studies, Charles Darwin University, Ellengowan Drive, NT 0909, Australia

## Summary

Three main areas for further development of policies or regulatory options for animal genetic resources (AnGR) were identified in a study on the exchange, use and conservation of AnGR (Hiemstra *et al.*, 2006):

1. how to halt the further erosion of genetic diversity and promote sustainable breeding and use,
2. whether there is a need to further regulate the exchange of genetic material and
3. how to balance different systems of property and use rights.

This paper provides an in-depth analysis regarding the third challenge, that of addressing the problems and options available for balancing the different property right systems for AnGR.

## Résumé

On a identifié trois domaines principaux pour le développement futur de politiques ou règlements pour les ressources génétiques animales (AnGR) dans une étude sur l'échange, l'utilisation et la conservation des AnGR (Hiemstra *et al.*, 2006):

1. Comment empêcher l'érosion de la diversité génétique et promouvoir une amélioration et utilisation durable.
2. Quand est-il nécessaire de réglementer les échanges de matériel génétique.

3. Comment harmoniser les différents systèmes de propriété et droits.

Cet article présente une analyse détaillée du troisième point, c'est à dire, comment approcher les problèmes et quelles sont les options disponibles pour harmoniser les différents systèmes de droits de propriété dans le domaine de AnGR.

## Resumen

Se han identificado tres áreas principales para futuros desarrollo de políticas o reglamentos para los recursos zoogenéticos (AnGR) en un estudio sobre el intercambio, la utilización y conservación de AnGR (Hiemstra *et al.*, 2006):

1. Cómo impedir la erosión de la diversidad genética y promover una mejora y utilización sostenible.
2. Cuando es necesario reglamentar el intercambio de material genético.
3. Cómo armonizar los distintos sistemas de propiedad y derechos.

Este artículo presenta un análisis detallado del tercer punto, es decir, cómo enfocar los problemas y cuales son las opciones disponibles para armonizar los distintos sistemas de derechos de propiedad en el campo de AnGR.

**Keywords:** AnGR, Regulatory options, Patent, Sui generis, Breeders' rights and livestock keepers' rights

<sup>1</sup> This paper summarizes the main findings on property right issues of a study by Hiemstra *et al.* (2006) entitled "Exchange, use and conservation of animal genetic resources: policy and regulatory options". The study was commissioned by FAO and funded by the Government of the United Kingdom of Great Britain and Northern Ireland, through DFID. The views expressed in the study and in this paper are the sole responsibility of the authors. The full report is downloadable from: [www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/](http://www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Policy+advice/)  
[www.cgn.wur.nl/UK/CGN+General+Information/Publications/2006/](http://www.cgn.wur.nl/UK/CGN+General+Information/Publications/2006/)  
[www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR\\_policy\\_and\\_regul.pdf](http://www.fao.org/ag/againfo/subjects/en/genetics/documents/ITWG-AnGR4/AnGR_policy_and_regul.pdf)

## Introduction

The analysis of different property right and legal systems (in this paper) forms part of a larger study by Hiemstra *et al.* (2006) into how exchange practices regarding AnGR affect the various stakeholders in the livestock sector.

The study's main objective was to identify policies and regulatory options for the global exchange, use and conservation of AnGR (Hiemstra *et al.*, 2006 and Hiemstra *et al.*, this issue). The background for FAO to commission this study was a recommendation from the Intergovernmental Technical Working Group on Animal Genetic Resources (see: CGRFA/WG-AnGR-3/04/REPORT, paragraph 24). The analysis of policy and regulatory options available is based on literature surveys, scenarios analysis and stakeholder consultations (Hiemstra *et al.*, 2006; Drucker *et al.*, this AGRI issue).

Different legal systems and types of property rights are relevant to AnGR. The current legal framework shapes the freedom to use, breed and sell AnGR on national, regional and global levels. For farm animals and thus also for AnGR, private ownership is the rule and public domain the exception. The principal point of departure is that the owner of the individual animal has the right to use the genetic resources in further breeding or even to sell genetic material (for a more profound discussion of ownership of AnGR, see Hiemstra *et al.* 2006, pp. 15–16; Tvedt *et al.* 2007, pp. 8–10).

The right to use the animal in breeding is often specified in a (formal or informal) contract between the seller and the buyer of the animal. The contract or informal agreement determines the scope of what is transferred and which rights still belong to the seller (if any). Contracts imply a dynamic element in establishing (or transferring) rights from one owner to the other. The most important limitation of the use of a contract is that it only applies between two parties, and has limited legally binding effects for third parties (For a more detailed discussion of contracts, see Tvedt *et al.*, 2007, p. 11–12).

Intellectual property rights are also used in the animal sector. Currently, the most familiar is a trademark. A trademark is a "sign, or any combination of signs, capable of distinguishing the goods or services" that may add value to a product by distinguishing the product from other similar products in the market (TRIPS Article 15).

Thus a trademark does not target the AnGR *per se*, but products developed from animals. Geographical indications can protect "indications which identify a good as originating in the territory of a

Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin" (TRIPS Article 22, paragraph 1). Similar to trademarks, geographical indications do not protect the breed or genetic material *per se*, but may add commercial value to the animals or breeds produced in a particular region. A third type of intellectual property right which is relevant for AnGR are patents (see Section A below).

This paper addresses the problems of, and options available for, balancing different property right systems for AnGR. Three groups of regulatory options can be identified:

1. Patent law and animal breeding.
2. *Sui generis* protection in animal breeding.
3. Livestock keepers' rights.

Section A explains the current situation regarding patent law as applied to the animal breeding sector. Section B identifies possible *sui generis* systems, which could be (further) developed for AnGR. Section C elaborates further on the specific issue of livestock keepers' rights (or farmer's rights). Finally in Section D we summarize our main conclusions and highlight key issues to be discussed in international forums.

## Section A. Patent Law and Animal Breeding

Patent law is general in scope, applying to all fields of technology and innovation [for a more in-depth analysis of how patent law applies to animal breeding and AnGR, see Tvedt (2007, forthcoming) and Nuffield Council on Bioethics (2001) regarding an analysis how patent law applies to genes in general]. Consequently, it does not necessarily take into account the specific needs and challenges of AnGR or the animal breeding sector (Tvedt 2007, Rothschild and Newman 2004 and Rothschild and Newman 2002). The main legitimacy of this existing legal framework rests in its contribution to innovation, research and development. If patent law is not contributing to increased research and development in this field, the time-limited monopolies can hardly be justified. One concern for AnGR is that a high number of claims, as is common for patent applications in the plant sector, may lead to the establishment of a significant body of exclusive rights with substantial impact upon the use of AnGR by researchers, breeders and farmers. The potential consequences are yet to be seen.

In the plant breeding sector, the main rule is that Plant Genetic Resources (PGR) are in the public domain and open to use by everyone. This is quite different from the case of AnGR, which are often in individual or communal private ownership. It may well be that the need to maintain a viable public domain for AnGR is not as important as it is for plants (For an analysis of public domain for genetic resources in general, see Tvedt 2005). However, if patent protection is granted with a low requirement of inventiveness and novelty (potential examples are in fact in the process of being granted (see Fitzgerald 2005), and if granted broadly in terms of scope, research and breeding activities which were previously widely possible might become more restricted. In some cases this could even impact traditional uses in the country of origin. Due to the short history of applying patents to AnGR, there is an absence of case law and scholars commenting on how these general principles of law will be applied in this particular area. In this context, this study has identified the following questions that may raise particular problems in the future.

### Patentability in the animal sector

The question of what types of inventions are eligible for patent protection was previously left to the discretion of each country. This was radically altered by the Agreement on Trade-Related Intellectual Property Rights (TRIPS Agreement) under the WTO, which establishes a comprehensive scope of patentability by requiring all member countries to provide for patent protection in all fields of invention, save for some narrow exemptions: Countries are allowed to exempt patent protection of animals other than micro-organisms, and for essentially biological processes (TRIPS Agreement 27, paragraph 3).

The TRIPS Agreement essentially creates opportunities for exempting animals other than micro-organisms from product patent protection in national patent law. The practical implications of this exemption depend upon the interpretation of the legal concept 'other than micro-organisms'. There is no definition or any agreed understanding of the term 'micro-organisms' among the parties to the TRIPS Agreement. Thus, countries have significant discretion as to whether to include or exclude animals, animal-proteins, genes and cells under patent protection in their national patent

system, which may have a significant impact on biotechnology. One linguistically possible interpretation of this term is that countries have the freedom to exempt product patent protection for every category of animal-related biological invention except those being clearly recognised as micro-organisms in a biological sense [Correa (2007, p. 293); Westerlund (2001) takes the opposite position and argues that the exemptions should be interpreted narrowly, see also de Carvalho (2005)].

Consideration of the patent applications received under the WIPO Patent Cooperation Treaty system shows that process patents are highly relevant for the animal sector (Tvedt, 2007) and that countries are highly likely to grant process patents in the field of animal breeding. The TRIPS article 27 paragraph 3 opens for countries to exempt "...essentially biological processes for the production of [...] animals", but obliges countries to delimit such an exemption and provide for patents to "other than non-biological and microbiological processes". The essential question is what is an "essentially biological process"? A WIPO official, de Carvalho, argues that this wording should "... be read in a restrictive manner...", since it is an exemption and maintains that: "...there are processes which are biological, to the extent they comprise some phase in which biological reproduction is employed, yet their most important steps consist of acts of human direct interference. These processes, in essence, are not biological" and must therefore, according to him, be patentable according to his understanding of the TRIPS Agreement (de Carvalho 2005, pp. 217-218). Correa notes that "...its main aim in the TRIPS Agreement context is probably to limit the exclusion of patentability to traditional breeding methods [...]" (Correa 2007, p. 293). Note that neither of them are discussing this issue particularly within the context of the animal breeding sector. As the TRIPS agreement does not specify the legal concept further, countries have some discretion to implement a broad or narrow definition and practice of the concept of essentially biological processes for the production of animals. The experience from the EU Directive on the legal protection of biotechnological inventions (EC/98/44) shows that this discretion has in fact been used to implement a narrow exemption from patentability in Europe (Tvedt, 2007). We may therefore expect differences among countries with regards to the scope of patentability both for product and process patents, but as a general rule patent protection can be expected to become widely available in the field of animal breeding.

## Prior art

The concept of 'prior art' relates to what is considered to be a body of information which cannot be patented. In principle, everything already known should be considered part of prior art and thus ineligible to meet the patent criteria. However, this is only a formal point of departure as the national patent office must put this principle into practice. For an activity where the current practices or prior art are not necessarily published in a sufficiently formal manner, there is a concern that common knowledge could conceivably become patent protected. To avoid such occurrences, measures could be taken to ensure that all relevant sources be covered during the prior art search process. Such a measure could be implemented by expanding the check-list for patent offices when they search for prior art.

Although preventive publishing is often put forward as a strategy to ensure that common knowledge will be considered prior art, it should be taken into consideration that such publishing only prevents patents from being granted in relation to that specific and particular form of published information. This means that preventive publishing may prove to be less effective in protecting against small adaptations to what was originally published. The large number of patent applications for different breeding methods which are currently being considered by patent offices is already increasing the challenge of identifying relevant prior art.

## Novelty and inventiveness

The novelty of an invention is considered by comparing the prior art with the invention described in the patent claims. If these two textual sources are identical the novelty criterion is not met and the patent should not be granted. In technical areas where extensive publication is not the norm, the chance of meeting the novelty criterion is higher than for areas where there is an extensive body of publications. The livestock sector might thus be exposed to many patent applications meeting the patent criterion even if they are not particularly novel in a practical sense. The same items of prior art are used to assess inventiveness. If a low level of inventiveness is required, a granted patent may include what was de facto already known or in practice. Practical measures to deal with these problems include the development of specific

guidelines for patent offices relating to how such assessments should be conducted. Such specific guidelines would of course have to comply with the requirement in the TRIPS Agreement, which states that patent protection is granted without discrimination among the various technological fields. Specific regulation of aspects of biotechnology patents is already accepted by the EU Directive on Biotechnological Patents (EC/98/44), so the TRIPS Agreement does not close the door to adapting special guidelines for single areas of invention. The general conclusion with regard to AnGR issues is therefore that an important gap needs to be addressed in order to ensure that methods already in existence do not become patented due to a lack of formal publications.

## Scope of the granted right

After a patent is granted, the next task is to determine the scope of the exclusive right that the claims would confer to the patentee. According to the TRIPS Agreement, Article 28, the scope of a process patent protection is:

*"... (b) where the subject matter of a patent is a process, [it confers a right] to prevent third parties not having the owner's consent from the act of using the process, and from the acts of: using, offering for sale, selling, or importing for these purposes at least the product obtained directly by that process."*

The process patent covers an exclusive right to the use or application of the described method. But the scope of protection extends also to cover at least the product obtained directly by that process. This means that the scope of process patent protection in the TRIPS Agreement requires countries to provide for indirect product patent protection that covers the outcome from the use of a patented method. Using a patented process might therefore give the patentee a legal position in relation to the offspring from the application of the process. This is highly relevant for the breeding sector as the next generations of animals bred by applying a patented method might become subject to the exclusive right.

In addition to concerns regarding the above principles and the granting of patents, the application of the principle of equivalence may create further difficulties when applied to livestock sector issues. The scope of what is covered by a patent is described in the patent claims. While interpreting the written patent claims, in some countries the scope of patent protection is made



even broader than it appears from a reading of the patent claims. The invention as described in the patent claims might be interpreted to become wider to also cover inventions that are so-called 'equivalent' to the invention described in the patent claims. If such an expansive 'doctrine of equivalence' is applied, there is a possibility of restricting someone else's potential to carry out breeding and/or research activities. Little attention has been given to this principle in patent law and none for the area of animal breeding. It is nevertheless an important issue, as it might become a significant factor in establishing broad exclusive rights. This will have unforeseeable consequences for AnGR. Since there hardly is any case-law dealing with these questions in the livestock sector, there is a need for a thorough, systematic legal analysis related to assessing how general patent law rules will apply to AnGR and breeding (for further details, see Tvedt 2007).

### Exemptions to patent protection

An additional measure for supporting the adaptation of patent law could involve the identification of useful exemptions that would lead to a more balanced application of patent law vis-à-vis the livestock sector (for an analysis of the balancing of property rights in the aquatic sector, see Rosendal 2006). In this context, it is important to note that although a patent grants the exclusive right to use an invention as it is described in the patent claim, Article 30 of the TRIPS Agreement specifies that "countries have discretion to implement exemptions in the right conferred by the patent on a general level in the patent act". One example of such an exemption applies to plants in Europe, where the EU Patent Directive Article 11 implements a version of the 'farmers' privilege' – i.e. the right of the farmer to reuse his harvest as seeds under certain specific conditions even if those seeds contain a patented gene. There is a similar opening for EU countries to implement an exemption in the animal sector according to the directive and a wide discretion for all countries according to the TRIPS Agreement. Nevertheless, surprisingly few developing countries have implemented such legitimate exemptions in their patent legislation.

Finally, it is also worth considering the degree to which patent protection is needed in practise to promote breeding, research and development in this sector. While the issue of increased bureaucracy is often raised as a counter argument to the

implementation of CBD-based access legislation, it should also be taken into consideration that the patent application process and subsequent enforcement are also time-consuming, expensive and heavily dependent upon the involvement of lawyers. It would therefore be useful to assess what the potential benefits of patent protection might be for breeding, research and development in this sector, taking into account the fact that the investments of breeders and others need to be protected. This would need to be weighed against any potential costs, e.g. increased costs of breeding material and reduced exchange and use of AnGR.

### Section B. *Sui Generis* Protection in Animal Breeding

The term '*sui generis*' is not a clearly defined legal term or concept in international intellectual property law. The TRIPS Agreement talks about "an effective *sui generis* system" for the protection of plant varieties as an alternative to providing patent protection to the same subject matter. But the TRIPS Agreement does not itself define such a system 'of its own kind' – a *sui generis* model for plant variety protection. One example of such a *sui generis* system for the protection of plant varieties are the plant breeders' rights under the different versions of the UPOV Convention. *Sui generis* systems for traditional knowledge have also been on the agenda at the World Intellectual Property Organisation (WIPO) for some years, but agreement on such an international system is still far off. If a *sui generis* system for AnGR were to be developed, it is crucial that the differences between plants and animals are carefully taken into account.

For AnGR it is not immediately apparent which subject matter requires further intellectual property protection. Where such a subject matter is identified and could be protected within the context of a *sui generis* system, then there is still a need to clarify *inter alia* i) who needs protection, ii) which entity should be the holder beneficiary to the right, iii) what should be the criteria for achieving protection, and iv) what should be included under the exclusive right. In the following section four options for *sui generis* protection are discussed:

#### Animal variety or breed protection

In considering the application of an intellectual property right such as a *sui generis* system for

AnGR or the breeding sector, defining the precise subject matter that should be protected by the right is clearly important. Compared to plant variety protection, providing intellectual property protection for 'animal varieties/breeds' would not make much sense due to biological reasons. The variety/breed is probably not the most relevant entity in animal breeding, but rather the individual breeding animal or its germplasm. Furthermore, the concept of an animal variety/breed is not easily defined. Such considerations mean that in terms of development of a *sui generis* system for the livestock sector, it would be difficult to identify characteristics that could serve as a standard description of the 'subject matter'. Further work is required to clarify the relevant subject matter for protection.

### Establishment of breed associations

A *sui generis* system could be linked to eligibility for being included in a particular register or herd book (managed by a breed association). Under such a *sui generis* protection system, registration would lead to the establishment of a right and the criteria for being granted that right are those required for being registered. The difficult question here is what the rights (and legal consequences) conferred by such a registration should entail. For example, should such registration give any exclusive rights to the genetic material? One alternative could be that registration gives rights to the individual animal. However, such registration would not add much in addition to the already held physical property right over the animal plus the complete genome of the particular animal in question. A second alternative could be that registration of individual animals also confers an exclusive right to single genes or alleles in the registered animals. This alternative is however problematic, as single genes or alleles often occur in a similar form in different individual animals and there is a need to avoid creating competing exclusive rights to the same gene. A third alternative could be that only those farmers and breeders with animals registered by the breed association have the right to use the name or brand of the breed. Such a '*sui generis* protection' would be more similar to a regular trademark approach. Establishment of breed associations or herd book registration (governed by breeding laws) combined with trademark protection could therefore be a good option for breed conservation and property right protection.

### Rights to genetic material of individual animals

One might also think about establishment of a *sui generis* right to the genetic material of the individual animal. With reference to the second alternative in the preceding paragraph, the first problem associated with such a right is the parallel occurrence of similar or identical genes and alleles in other animals. This would either undermine the exclusivity of such a right or result in competing property right claims. In addition to the problems related to identifying such genes, establishing a general *sui generis* right to the genes of the individual animal would probably not add anything new compared to ownership of the animals.

### Geographical related properties

A *sui generis* protection could also be linked to special geographical related properties and characteristics of the animals or their products (geographical indications). A final alternative for a *sui generis* system would be to leave it to the breeder to characterise in a sufficiently precise manner as to what s/he claims as an exclusive right. This could then be used to establish a system for securing rights to technological developments and provide, for example, protection for a single gene when isolated and described. Such protection is however already provided by the existing patent system.

### Summing up options for *sui generis* systems

To sum up, there are a number of relevant subject matters for intellectual property protection:

- At the level of the individual animal – protection is conferred by physical ownership of that animal and/or its offspring. Rights transferred during the purchase/sale of individual animals can be protected through the use of contracts.
- At the breed level – protection through the establishment of breed associations (or herd books) and the use of trademarks may be appropriate
- At the allelic, gene or protein level – protection is provided by patent law.

- Technical inventions relevant for breeding - protection would be covered by current patent law.

The conclusion on *sui generis* intellectual property rights in the animal sector is that it is not easy to identify the subject matter which needs to be protected. If a *sui generis* system were to be developed there would be a need for a more profound theoretical analysis in close cooperation with breeders to identify the subject matter that needs further intellectual property protection. Such an analysis would also need to identify the necessity of stimulating breeding and innovativeness by using such a legal system.

## Section C. Livestock Keepers' Rights

Livestock keepers' rights or farmers' rights to animals are unexplored legal or political concepts in the livestock sector. The term 'farmers' rights' is mentioned in Article 9 of the ITPGRFA (FAO International Treaty on Plant Genetic Resources for Food and Agriculture). Farmers' rights 'recognize the enormous contribution' farmers have made regarding plant genetic resources (PGR). Responsibility for realizing such rights rests with national governments and there is a clause specifying that Article 9 shall not limit any already existing 'rights that farmers have to save, use, exchange and sell farm-saved seed/ propagating material, subject to national law'. From a legal point of view, these 'rights' are not formulated in a legally binding sense, which raises issues about their enforcement in practice.

Implementing a version of farmers' rights for livestock keepers (e.g. as formulated in such documentation as the 'Karen Declaration', which includes support for indigenous knowledge remaining in the public domain and that AnGR needs to be excluded from IPR claims) would first require similar international recognition of their crucial role and contribution to AnGR.

Different strategies have been suggested for securing livestock keepers' rights, and these include codifying the customary laws that relate to the management of AnGR. A first step in this direction would be to review and analyse relevant customary law in order to identify which principles need to be included. Given that grazing rights are crucial to

maintaining pastoral societies and are thus closely linked to conservation both at a breed level and at an allelic level, livestock keepers' rights could include production and grazing rights, as well as the protection of traditional knowledge.

Mechanisms to strengthen livestock keepers' understanding of AnGR issues, their negotiating capacity and access to legal support would also necessarily be a crucial element of a strategy for developing livestock keepers' rights.

Obstacles to the implementation of livestock keepers' rights include the fact that they could conflict with other intellectual property rights. For example, if a patent on a particular gene existed, the consent of the patent holder could be required when animals that express that gene were used for further breeding. Addressing this potential conflict is not however an insurmountable problem. For example, India has developed a Farmers' Rights law which carefully balances these rights for crop seeds. Similarly, where livestock keepers' rights could potentially conflict with other intellectual property rights, there would be a need to have rules governing how these interests should be taken into account within the highly specified and enforceable body of patent law. One approach would be that livestock keepers' rights could *inter alia* be relevant for inclusion both when assessment of the patent criteria is carried out, as well as during enforcement. However, since livestock keeper practises are typically not published in a manner qualifying as prior art according to the patent system, this might expose them to patenting even if not new in a *de facto* sense. Two alternative approaches might also be considered:

1. either single countries could implement exemptions to intellectual property rights for livestock keepers; or
2. standard exemptions could be developed at a regional or multilateral level.

It is also possible to imagine some form of a *sui generis* protection system for livestock keepers' rights. This concept would have to be developed further on a theoretical level, but could include a model for benefit sharing or could combine individual and community rights over AnGR. A crucial issue in the development of such a concept would be whether a *sui generis* system should include a positive right to exclude others or whether

it should be geared towards being a negative right aiming at preventing misappropriation of what is in use by livestock keepers.

## Section D. Conclusions: How to Balance the Rights of Stakeholders in the Livestock and Animal Breeding Sector

'Classical ownership' of AnGR includes physical ownership and communal 'law of the land' affecting livestock keeping and breeding. The existing use of contract law in a more or less explicit manner is functioning rather well in the area of animal breeding. There is, however, an increasing tension with developments in the realms of biodiversity law and intellectual property rights protection. Demarcation of these different rights systems and maintaining equity among different stakeholders is crucial to avoiding conflict and increased transaction costs. In this context, it is important to consider the rights of livestock keepers vis-à-vis national level sovereign rights, as well as obligations between patent holders and breeders/livestock keepers. Balance is not easily achieved as breeders have a need to protect their new investments as well the current practices which are functioning and thus need not to be altered.

There are several potential options that could be explored in order to better balance the rights of different stakeholders in the livestock sector under a range of future scenarios. For example specific exemptions in patent law as applied to the animal sector could be implemented. This is already a well-known strategy from in the crop sector. Key issues related to the patent system also could be considered and these include: up-dating the prior art search practice, reviewing patent criteria for assessing potential innovations relating to AnGR, and/or implementing exemptions for livestock keepers and breeders.

*Sui generis* protection options for AnGR could also be explored, including through protection of breeds via the establishment of breed associations, defining livestock keepers' rights and assessing other strategies to secure investments. Note also that since livestock keepers' rights are in an early phase of development as a legal concept, further development is likely to require the identification of the needs of livestock keepers and how these needs can be addressed through the use of international policy or legal instruments.

The overall conclusion of this paper is that property rights need to be adequately adapted to the field of AnGR to be conducive to the exchange, conservation and sustainable use of AnGR. A second main observation is that for these purposes the balancing of property rights may not also be easily achieved. This is because breeders have a need to protect their new investments, while current practices are functional and thus do not need to be altered. Exploration of the options discussed in this paper may however assist in this task.

## List of References

- Correa, C.M.** 2007. Trade Related Aspects of Intellectual Property Rights: A Commentary on the TRIPS Agreement, Oxford University Press, Oxford.
- de Carvalho, N.P.** 2005. The TRIPS Regime of Patent Rights, 2<sup>nd</sup> edition. Kluwer Law International, The Hague.
- Hiemstra, S.J., A.G. Drucker, M.W. Tvedt, N. Louwaars, J.K. Oldenbroek, K. Awgichew, S. Abegaz Kebede, P.N. Bhat & A. da Silva Mariante.** 2006. Exchange, Use and Conservation of Animal Genetic Resources: Identification of Policy and Regulatory Options. CGN Report 2006/06. Centre for Genetic Resources, Wageningen, The Netherlands.
- Nuffield Council on Bioethics.** 2001. The Ethics of Patenting DNA. London: The Nuffield Foundation of Bioethics.
- Rosendal, K.G., I. Olesen, H.B. Bentsen, M.W. Tvedt, & M. Bryde.** 2006. Access to and legal protection of aquaculture genetic resources: Norwegian perspectives, *Journal of World Intellectual Property* 9, 392-412.
- Rothschild, M.F. & S. Newman (Eds).** 2002. Intellectual Property Rights in Animal Breeding and Genetics. New York: CABI Publishing
- Rothschild, M.F., G. Plastow. & S. Newman.** 2004. Patenting in animal breeding and genetics, in A. Rosati *et al.* (Eds) WAAP Book of the Year 2003. Wageningen Pers, for World Association for Animal Production (WAAP)

---

**Tvedt, M.W., S.J. Hiemstra, A.G. Drucker, N. Louwaars & K. Oldenbroek.** 2007. Legal Aspects of Exchange, Use and Conservation of Farm Animal Genetic Resources. FNI Report 1/2007. The Fridtjof Nansen Institute, Lysaker, Norway.

**Tvedt, M.W.** 2007 forthcoming. Patent protection in the field of animal breeding and farm animal genetic resources, ACTA Scandinavia.

**Tvedt, M.W.** 2005. How will a substantive patent law treaty affect the public domain for genetic resources and biological material? *Journal of World Intellectual Property* 8, 311-344.

**Tvedt M.W.** 2007. 2005. Monsanto files for new invention: the pig, [www.greenpeace.org/international/news/monsanto-pig-patent-111#](http://www.greenpeace.org/international/news/monsanto-pig-patent-111#).

**Westerlund, L.** 2001. Biotech Patents – Equivalency and Exclusions under European and U.S. Patent Law. Faculty of Law, Stockholm University, Stockholm, Sweden.



## Genetic impact assessments – summary of a debate

*D. Pilling*

*Animal Production and Health Division, FAO, 00153 Rome, Italy*

### Summary

Some countries have introduced a requirement for genetic impact assessments prior to granting permission for the import of new exotic livestock breeds. However, the merits of such a system are not universally accepted. During February 2007 a discussion on the subject took place on FAO's Domestic Animal Diversity Network (DAD-Net) electronic forum. This paper presents a description of how the discussion developed, and a summary of the issues raised. Arguments both for and against requiring impact assessments were put forward. Those opposing such measures focused on the risks of limiting access to animal genetic resources (AnGR), and questioned the benefits of government interference. Practical constraints to implementation and enforcement were also noted. Counter arguments pointed to the potential for avoiding the loss of valuable AnGR, and stressed governments' responsibilities to intervene where necessary to promote sustainable development, to defend the interests of the poor, or to protect national heritage. The debate ranged more widely – encompassing the respective roles of local and exotic AnGR in different regions of the world and in different production systems.

### Résumé

Certains pays ont introduit le besoin d'évaluation de l'impact génétique comme condition pour l'obtention du permis d'exportation de nouvelles races exotique. Cependant, l'importance de ce système n'est pas mondialement reconnu. En février 2007 a eu lieu une discussion à ce sujet au sein du forum électronique du Réseau pour la Diversité des Animaux Domestiques de la FAO. Cet article présente une description du déroulement de la discussion et un résumé des objectifs atteints. On décrit les arguments à faveur ou contre l'évaluation de l'impact. Les oppositeurs à ces mesures ont

présenté les risques que comporte limiter l'accès des ressources génétiques animales (AnGR) et ont remis en question les bénéfices de l'interférence gouvernementale. Les argument exposés dans ce sens soulignent la potentialité d'éviter la perte d'une partie importante de AnGR et insistent sur les responsabilités des gouvernements dans leur intervention sur la promotion du développement durable, la défense des intérêts des plus pauvres ou la protection de l'héritage national. Le débat s'est étendu ultérieurement pour inclure les rôles des AnGR au niveau local et exotiques dans les différentes régions du monde et différents systèmes de production.

### Resumen

Algunos países han introducido la necesidad de la evaluación del impacto genético como condición para la obtención del permiso de exportación de nuevas razas exóticas. Sin embargo la importancia de este sistema no está reconocida a nivel mundial. En febrero 2007 se mantuvo una discusión a este respecto en el foro electrónico de la Red sobre la Diversidad de los Animales Domésticos de la FAO. Este artículo presenta una descripción sobre el desarrollo de la discusión y un resumen de los objetivos alcanzados. Se describen los argumentos a favor o en contra de la evaluación de impacto. Los opositores a estas medidas se centraron en los riesgos que supone limitar el acceso de los recursos zoogenéticos (AnGR) y cuestionaron los beneficios de la interferencia estatal. También se plantearon las limitaciones prácticas para reenforzar y llevar a cabo este proceso. Los argumentos expuestos en este sentido subrayaban la potencialidad de evitar la pérdida de una parte importante de AnGR, insistiendo sobre las responsabilidades de los gobiernos en su intervención en la promoción del desarrollo sostenible, la defensa de los intereses de los pobres o en la protección de la herencia nacional. El debate se extendió ulteriormente para incluir los respectivos roles de los AnGR locales y

exóticos en las distintas regiones del mundo y en diversos sistemas de producción.

**Keywords:** *Animal genetic resources, Genetic impact assessment, Regulations.*

## Introduction

This paper presents an overview of an exchange that took place on FAO's Domestic Animal Diversity Network (DAD-Net<sup>1</sup>) during February 2007. Central to the debate was the question of genetic impact assessments - whether there should be a requirement for such a study prior to the import of new exotic animal genetic resources (AnGR) into a country. However, the discussion ranged more widely, encompassing the roles and relative merits of exotic and local breeds in livestock development in different regions of the world and different production systems, and the roles of various stakeholders (farmers, governments, commercial interests) in decision-making.

The widespread interest in the topic was clear; a single request for information sparked a spontaneous exchange which ran to almost 60 messages posted over a 15-day period. Participants from at least 25 countries and all regions of the world<sup>2</sup> contributed their views. A number of new subscribers joined DAD-Net in order to participate or to follow the discussion. The objective here is to bring the debate to a wider audience.

DAD-Net is managed by the Animal Production and Health Division of FAO. The purpose of this electronic service is to provide an informal forum for the discussion of issues relevant to the management of AnGR at national, regional and international levels. After free registration users receive all messages posted. Users are encouraged to post messages on topics of interest related to the management of AnGR, and are also invited to contribute articles or other information in English, French or Spanish dealing with the following subjects: characterization, conservation, utilization, breeding, data and information management, training and education, emergency planning and response, research and technology transfer, and any other subject they consider relevant to AnGR. FAO

periodically contributes information and acts as moderator. DAD-Net has around 1 000 subscribers; at the time of writing, 520 messages had been posted since its launch in February 2005.

## Development of the Discussion

The message that initiated the discussion was a simple question: is South Africa the only country in the world that demands impact assessments prior to the import of a new exotic breed? The message explained that the question was prompted by the surprised reaction of an agent from a European country when he learnt of this requirement. Further messages supplied DAD-Net subscribers with the wording of the South African guidelines (Department of Agriculture, 2003), and an FAO document that had been used in their preparation (FAO, 1994). The guidelines indicate that any party wishing to import new exotic breeds has to arrange for an impact study to be conducted by reputable animal scientists. The completed study has to be evaluated before the breed will be considered for recognition and importation under the terms of the Animal Improvement Act, 1998 (Act No. 62 of 1977). There may be a requirement for a further on-site evaluation. For further details of the guidelines, see Appendix 1.

Initial responses were generally supportive of the South African measures. Participants from two European countries (Iceland and Spain) indicated that their countries also required impact assessments. It was a message posted by a participant from Brazil that stimulated much of the subsequent discussion. Two related points were raised:

- Exotic genetic resources (Zebus) have been vital to the Brazilian cattle industry (including small-scale producers) although there was strong opposition to their introduction during the early twentieth century.
- This example illustrates that decisions are better left to the farmer, and that government interference should be avoided.

The implication seemed to be that genetic impact studies are unnecessary and, indeed, are likely to do more harm than good. The following sections

<sup>1</sup>DAD-Net@fao.org

<sup>2</sup>Africa, Asia, Europe, Latin America and the Caribbean, the Near East, North America and the Southwest Pacific.



present a summary of the main arguments put forward during the subsequent discussion.

## Arguments Against Genetic Impact Studies

A key argument put forward by those opposing impact studies related to the need to avoid restricting the options available to breeders and livestock keepers. Put more forcefully, the suggestion was that too much emphasis on keeping local genetic resources in use compromises food security and prevents farmers from improving their livelihoods. According to this view, it is the livestock keepers who are the best judges as to what AnGR are appropriate for the circumstances in which they make their living; it is they rather than the government officials who bear the risks associated with such decisions.

It was also argued that it is impossible to use legal means to prevent breeders from obtaining the genetic resources they want. Moreover, it was pointed out that if governments are at present unable or unmotivated to protect their local AnGR, it is questionable if they should be trusted to organize effective impact studies and abide by the findings. The cynical view was that the desired outcome could always be arranged.

Other practical concerns were raised including the question of how national-level restrictions of imports could account for the diversity of the production systems that exist within many countries. Either some potential users will be denied appropriate resources, or once imported there is a risk that AnGR will 'leak' into systems to which they are not adapted. Another question related to how an impact assessment could account for the many different potential cross-breeding combinations for which an introduced breed might be used.

It should be noted that the participants who cast doubt on the role of genetic impact assessments stressed that they were not questioning the importance of maintaining local breeds or the need for governments to support conservation measures. Neither should it be concluded that all those who oppose restrictions on imports do not recognize the importance of a policy framework to manage the utilization of exotic AnGR. One participant suggested that rather than keeping exotic breeds out, the real requirement was structures to be put in place to allow the development and testing of

breeds within the country to ensure optimal utilization. There was another suggestion that while there should be no restrictions on imports, those seeking to profit from importing germplasm should be obliged to contribute to data collection and monitoring activities within the country, and hence to the development of local AnGR.

## Arguments in Favour of Genetic Impact Studies

The objections described in the preceding section gave rise to a number of counter arguments. One set of arguments was based on comparing genetic impact assessments to the provisions put in place to regulate other aspects of livestock trade or of development projects in general. For example, governments impose import restrictions in order to protect veterinary and public health – a parallel was drawn between the need for such provisions and the need to defend the public goods embodied in local AnGR. Indeed, it was further argued that exotic imports could in themselves present a threat to a country's animal health status, as their susceptibility makes them effective carriers of diseases and parasites. Parallels were also drawn with the environmental (and social) impact assessments which have become widely required for the approval of development projects. Such studies, it was noted, need not be expensive unless a particular threat that requires deeper investigation is identified. The argument ran that the costs of these studies are generally regarded as worthwhile as they reduce the risk of a far more expensive environmental disaster in the future.

Another theme related to the availability of information. It was argued that breeders and livestock keepers do not always have the relevant information on which to make informed judgements regarding breed choices. The role of commercial interests that wish to promote the use of their products without regard for their suitability to the production environment was raised as a concern, including both lobbying of decision-makers and the supply of inadequate information to the farmer. Genetic impact assessments are seen as a means of countering such biases.

It was also argued that free trade in AnGR should not be seen as a goal in itself. According to this perspective, governments have a responsibility to intervene where necessary to promote sustainable development, to defend the interests of the poor or to protect the country's heritage.

## Roles of Local and Exotic Breeds

The demand for genetic impact assessments arises primarily because of concerns about the potential loss of genetic diversity through breed replacement or ill-considered crossing/upgrading. However, imports may influence not only the future availability of local AnGR, but also influence (for better or worse) current utilization – the economy, development objectives and the livelihoods of livestock keepers may be affected. It was, therefore, not surprising that the scope of the discussion broadened to encompass the respective roles (strengths, weaknesses, potentials) of local and exotic breeds within a country's livestock sector.

Where tropical countries are concerned, much of the discussion focused on the suitability, or otherwise, of temperate AnGR within local production systems. The problems associated with raising pure-bred temperate livestock in the tropics were widely acknowledged. Susceptibility to disease, poor tolerance of high temperatures, and poor adaptation to local feed resources greatly constrain the utilization of such animals. Animal welfare issues associated with the introduction of animals to environments to which they are not suited were noted. It was also recognized that consideration has to be given not only climatic and ecological conditions, but also the multiple roles that livestock are required to fulfil within smallholder production systems, and to which local animals tend to be well adapted. One situation in which it was noted that there is a need for careful assessment of the potential impact of the introduction of exotic AnGR was in the case of restocking projects carried out in post-disaster conditions.

There was, however, recognition of the contribution that temperate AnGR have made in the development of composite breeds utilized in the tropics/subtropics. Examples mentioned in the context of South Africa included Dorper and Afrino sheep, and Bonsmara and Drakensberger cattle. Attention was also drawn to the contribution of temperate × Zebu cross-bred dairy animals (Brazil being the main example cited). A paper outlining the role of exotic AnGR in Latin America was circulated to participants (Madalena, 2005). It was also pointed out that where there is a lack of capacity to organize breeding programmes for local breeds, the introduction of exotic AnGR often appears to be the only practical option to achieve genetic improvement. The need for improved management if the utilization of exotic AnGR in the tropics is to be a success was recognized. Cases in

which this has been successfully achieved (e.g. provision of improved forage and veterinary care for dairy cattle in Brazil) were cited. However, it was also noted that for some livestock keepers, meeting the costs of the additional inputs required by exotic or cross-bred animals can be prohibitive.

In the case of Latin America, both Zebus and European breeds are, of course, of exotic origin. A number of participants drew attention to this difference between the Old and the New worlds - the former being richly endowed with local breeds of the major international livestock species (cattle, goats, sheep, pigs, chickens etc) adapted to the local conditions, the latter lacking these species prior to European colonization. Although Zebus are exotic to Latin America, they are adapted to tropical conditions. In this context, it was interesting to note the rather different perspective emanating from Latin America as compared, for example, to that expressed by most participants from Africa who had a more favourable view of the importance of local breeds and the need for impact assessments.

Although most participants would probably share the view that both local and exotic AnGR have a contribution to make in the tropics, and that AnGR should be matched to the given production conditions, there certainly seemed to be differences of opinion as to where the balance should lie. Several participants cautioned against assuming too readily that exotic or cross-bred animals are the most appropriate for local production conditions, and cited some examples to support this case. Mention was made, for example, of the study by King *et al.* (2006), which revealed how heat stress and energy deficit constrain milk yield and cow replacement rates among Friesians kept on Kenyan smallholdings. Several messages emphasized the need for a more comprehensive understanding of the concept of productivity, particularly in smallholder production systems, including the use of a definition based on the efficient use of scarce resources and inclusion of the non-marketed benefits provided by the animals. The case study conducted by Ayalew *et al.* (2003) which found indigenous goats to be more productive than cross-breeds under smallholder conditions in the Highlands of Ethiopia was cited in this respect.

Concerns regarding the use of exotic AnGR to upgrade local breeds were summed up by one participant with the following quote taken from Hall (1992): "*There is ... a major risk that the best females of local breeds will be the first to be used for upgrading, which would erode the local breeds. Upgrading will foster a climate of contempt for local breeds and devalue traditional husbandry skills. It is*

*unlikely to benefit the smallholder farmer and hence may have limited contribution to the alleviation of rural poverty. However, such developments are very attractive to governments and aid agencies and are likely to continue."*

There was widespread recognition that the utilization of local breeds in developing countries is constrained by a lack of adequate characterization. The absence of long-term breed comparisons was noted as a problem. Similarly, there is a lack of capacity to implement genetic improvement programmes in local breeds.

Some participants emphasized the contributions made by exotic AnGR in both developing-country and developed-country (e.g. North American Holstein genetics in Europe) contexts. Others, however, warned against ignoring the valuable characteristics of local breeds – including their potential contribution to profitable commercial production. A participant from Canada argued against the view that the producer is always in a position to make the optimal choice of breeds. A lack of knowledge, and limited availability of alternatives in a market dominated by industrial-scale production, may mean that small-scale producers overlook potentially superior options – the example cited was that of the Bronze turkey in Canada. A participant from South Africa noted the great commercial potential of local pig breeds and of cattle breeds such as the Nguni – the latter having been almost wiped out by indiscriminate cross-breeding in the name of 'improvement'.

The risks to the livestock sector of policies promoting uniformity in pursuit of increased output were noted by some participants. In developed countries (Spain was cited as an example) high levels of milk production have been achieved, yet many producers struggle to make a profit. There is an urgent need for diversification. Local breeds that enable the farmer to exploit niche markets can be a valuable resource in this context.

## Concluding Remarks

The discussion summarized in this article arose spontaneously; it was essentially an informal and unstructured exchange of views. No attempt was made to arrive at a set of conclusions or recommendations. It would be inappropriate to attempt to do so here.

By their willingness to share their opinions the participants showed that they recognize the importance of debating policy and management

options for the sustainable use and development of AnGR. If one item of consensus can safely be identified, it is that there is a need for all stakeholders to be better informed about AnGR and strategies for their management. The DAD-Net discussion on genetic impact assessment was a contribution to this process.

## List of References

- Ayalew, W., B. Rischkowsky, J.M. King & E. Bruns.** 2003. Crossbreeds did not generate greater net benefits than indigenous goats under improved management in Ethiopian smallholdings. *Agricultural Systems* 76, 1137–1156.
- Department of Agriculture.** 2003; Guidelines for a biological impact study. Possible introduction of a new breed of farm animal. Pretoria.
- FAO.** 1994. Implications of the Convention on Biological Diversity. Management of animal genetic resources and the conservation of domestic animal diversity. Report of an informal working group, Animal Production and Health Division, UN Food and Agriculture Organization, Rome, Italy, 28–29 March 1994. Edited by M. Strauss. Rome.
- Hall, S.J.G.** 1992. Conservation of livestock breeds. In J.E.O. Rege & M.E. Lipner, eds. *African animal genetic resources: their characterisation, conservation and utilization*. Proceedings of the research planning workshop held at ILCA Addis Ababa, Ethiopia, 19–21 February 1992.
- King, J.M., D.J. Parsons, J.R. Turnpenny, J. Nyangaga, P. Bakari & C.M. Wathes.** 2006. Modelling energy metabolism of Friesians in Kenya smallholdings shows how heat stress and energy deficit constrain milk yield and cow replacement rate. *Animal Science* 82, 705–717.
- Madalena, F.E.** 2005; Considerations on the management of animal genetic resources in Latin-America. Paper presented at the EAAP/SLU/FAO/ICAR workshop on Sustainable Management of Animal Genetic Resources: Linking perspectives globally, Uppsala, Sweden, June 2, 2005.

---

## Appendix 1. South Africa's guidelines for impact assessment studies

The following requirements are outlined in the guideline document (Department of Agriculture, 2003):

1. The study should be undertaken by a reputable animal scientist, group of animal scientists or animal science institution (university, research institute).
2. Animal scientists or organizations in South Africa can be contracted to do the work.
3. The report must include color photographs of the breed.
4. Special attention should also be given to the possible use of the breed in developing areas in South Africa.
5. Where the importation of a limited amount of genetic material has been authorized for evaluation purposes, all animals and progeny must be recorded on the National database.

Further details of the framework for such studies are set out in table 1.

On receipt of the study, a decision will be taken with regard to the need for further evaluation on site.

Genetic material may be imported for further evaluation under the following conditions:

- “1. The import will be strictly for evaluation purposes and all animals and progeny must be recorded on the INTERGIS [Integrated Registration and Genetic Information System] as a breed under evaluation.
2. Participation in a relevant animal evaluation scheme (e.g. beef cattle or dairy cattle recording and evaluation scheme).
3. All animals and progeny must be identified by way of DNA.
4. No animals or genetic material may be disposed of in any way without the permission of the registrar.
5. No publication of results or any other information without the permission of the registrar.”

Table 1. Basic framework an impact assessment in South Africa

Subject	Details	Additional Comments
Breed description	Basic description	Type
	Color	Color
	Size (male, female, calf)	Weight, linear measurements
	Hair coat	Smooth, woolly, etc
	Origin	If a composite supply details of the development of the breed
	Grazing pattern	Is the breed a bulk grazer, browser, selective grazer etc. What impact can it have on the environment?
	Specific details	Details of fertility and growth under different conditions.
Normal production environment	Performance (reproduction and growth)	
	Feed conversion rate under field and stall conditions	
Known genetic defects	Milk production (dairy breeds)	Dairy breeds must include details of production and contents analysis
	Describe the environment where the breed occurs naturally	Where will the breed adapt best?
Production systems	Selected for e.g. double muscling	e.g. Belgian Blue and Piedmontese are selected for double muscling – mainly with a veal market in mind
	Selected against	List all known genetic defects that have occurred in the breed and the measures taken to control these
Level of management	Extensive beef production	Describe the production systems where the breed has been used. Supply statistics to verify production figures.
	Veal production	
	Industrial crossing	
	Production of feedlotters	Similar.
	Milk production	
Breeds in South Africa	Wool	
	Mutton etc.	
Impact on production systems in South Africa	Level of management required e.g. what management inputs are needed for optimal production	Evaluation the suitability of the breed for the small farm/ developing sector
	Any similar breeds already in South Africa E.g. the Australian Belmont Red is similar to the Bonsmara	What impact will the breed in question have on any similar breeds?
Impact on the indigenous livestock resources of South Africa	Asses the impact of the breed on production systems in South Africa	Specify areas where it could compete with similar breeds Specify areas where it could compete with indigenous and locally developed breeds
	Investigate the possibility of the breeds converging on indigenous breeds	A projected potential impact is particularly important where the breed in question is similar to local breeds and where it could lead to the erosion of local genotypes.
Impact	Could it lead to a projected loss in diversity?	Marketing
	Assess the quality of the genetic material	Is it better than any locally available breed?
Impact in other countries	Is it quality or surplus?	Certify that this is not surplus and that genetic material will not be made available at prices below the local semen market prices
	Supply case studies of where the breed has been introduced and its impact in the country in question.	This could be in the form of a literature study. But: List referees for each reference enabling verification and possible cross-referencing
	A developing country	
	A developed country	

Source: Department of Agriculture (2003).



## Country Contributions

Contributions from countries highlighting country actions in AnGR management based on and following the preparation of Country Reports on the State of AnGR

Bangladesh .....	111
Croatia .....	112
Ghana .....	113
Islamic Republic of Iran .....	114
Ireland .....	115
Madagascar .....	116
Union of Myanmar .....	116
Nigeria .....	117
Norway .....	118
Sultanate of Oman .....	118
Papua New Guinea .....	119
Poland .....	120
Serbia .....	120
Spain .....	122
Sweden .....	123
Viet Nam .....	124





## Bangladesh

Azharul Islam Talukder

National Co-ordinator for the management of AnGR

Livestock in Bangladesh consists of 22.3 million large ruminants (cattle and buffalo), 14.6 million small ruminants (goats and sheep) and 126.7 million chickens and ducks. The highest number of households (13.6 million) raises fowls followed by households who raise cattle (8.2 million), ducks (7.0 million), goats (5.6 million) and sheep (0.5 million). The least number of households were found to raise buffalo (0.3 million). The gross value of livestock in Bangladesh according to BBS (2000) is equivalent to about US\$ 426.3 million most of which is held by smallholders. The domestic animal genetic resources in the country are rich sources of valuable products like meat, milk, skin and genes of economic importance (disease resistance, capacity for production on poor quality management and product of special flavor or other quality) but few efforts are being made towards their conservation or sustainable development in food and agriculture.

The major imports of livestock products are powdered milk and live poultry while the major exports are leather, skin and animal casings. The average annual growth rate of meat and milk products is 3.7% and 4.2% respectively, and that of eggs about 7.7%. Animal agriculture receives priority attention from the public sector for the purposes of increasing the production of meat, milk and eggs to meet the growing demands of the country. Most of the livestock species are still reared under traditional production systems except for the considerable development of commercial poultry based on imported germplasm, feed and medicines. The available genetic resources of cattle may be classified as:

1. Native cattle (Pabna Red Chittagong, Munshigonj and North Bengal Grey cattle).
2. Crossbred cattle and exotic breeds (Holstein - Friesian, Shahiwal, Sindhi and Jersey).
3. Native buffalo and the Nili-Ravi exotic breed.

It is estimated that more than 90 % of total goat population in Bangladesh is comprised of Black Bengal goats, the remainder being Jamnapari and their crosses. Sheep in Bangladesh are mostly indigenous non-descript type. Native chicken

(Naked Neck, Hilly, Aseel, native dwarf type and Yasmine), five purebred and ten commercial strain chicken germplasm are available in the country. Non-descript indigenous type and Deshi White Pekin duck are limited to some duck farms in the public sector. The types of special fowls found in Bangladesh are geese, quail, pigeon and guinea fowl. The country also has genetic resources of pigs, horse, deer and dogs.

The national cross-boundary priorities for conservation and development of farm AnGR are:

1. Establishment of a coordination system for livestock development programs.
2. Breed surveys, population size estimation, risk assessment and characterization.
3. Formulation of national breeding policies for different AnGR.
4. Economic evaluation of AnGR and resource uses.
5. Breed diversity assessment and improvement.
6. Developing systems for regular recording and evaluation of production performance data of AnGR.
7. Strengthening livestock research and development (R&D) and technology transfer systems.
8. Strengthening of livestock production extension services.
9. Training and development of human resources.
10. *Ex-situ* conservation of germplasm.
11. Development of livestock marketing and quality control systems.
12. Acquisition of funding.
13. Promoting public awareness .
14. Encouraging formation of breed associations.

Global and regional cooperation and initiatives will assist identification of resource potentials and their utilization for economic and social development through application of biotechnology and other technological advances.

Bangladesh is an active partner in the on-going efforts to promote sustainable development of livestock; believes in capacity building to achieve better management of AnGR to help food security, poverty alleviation and employment generation, especially, for rural people; and responds to changing global demands and market preferences.

---

## Croatia

*Ante Ivankovic*

*National Co-ordinator for the management of AnGR*

The preparation of the Country Report on AnGR management has included a large number of experts who engage in the preservation of genetic resources. The guidelines for the preparation of the national AnGR report initiated a wider public debate on the harmonisation of the strategic lines of direction in the preservation of the entire genetic resource base. The meetings that followed gave answers to some of the questions raised, and tried to take into consideration the national and regional characteristics of Croatia. The preparation of the Country Report on AnGR management stimulated a revision of the scope of animal genetic resources in Croatia. A need to supplement the list of breeds that are included in the active care of the wider community has been noted, following the undertaking of a further revision and analysis of the state of genetic resources.

On the basis of a revision, the Busha, Murisland horse, Croatian Coldblood and the Tsigai breeds have been included in the list of protected breeds. With the aim of determining priorities relating to the more reliable protection of original breeds, a systematic molecular genetic determination is being

performed. In this way, the phylogenetic interrelation and the genetic originality of original breeds can be more clearly discerned, a basis for the subsequent tracking of gene flows is set and a priority list of breeds in the protection programme can be determined. Following the preparation of the national AnGR report, a program to reaffirm the economic potential of original breeds through the production of recognisable, refined and high-value foods has been initiated. There are several programs focussed on the organisation and standardisation of products currently in use, whose goal is to increase the economic benefits of production based on original breeds of domestic animals (Kulen, Pag sheep cheese, Istrian beef, etc.).

The preparation of the national report on AnGR management provided stimulation for a revision of the state of original breeds and the efficiency of the protection system. The First Report on the State of the World's Animal Genetic Resources will certainly be a new incentive in the completion and harmonisation of the existing system of protection of original breeds in Croatia, as well as in the exchange of experiences with other states, especially those that host related breeds.

---

---

## Ghana

*Richard Osei-Amponsah*

*National Co-ordinator for the management of AnGR*

Ghana accepted the FAO Director General's invitation to join the Sow-AnGR process in the late 1990s. Consequently, the Animal Production Directorate (APD) of the Ministry of Food and Agriculture (MOFA) was identified as the host institution. A broad-based and multi-disciplinary stakeholder National Consultative Committee (NCC) was formed and a National Co-ordinator appointed. The NCC identified the need to infuse the goals of the Sow-AnGR especially sustainable AnGR management for present and future generations, into Ghana's Livestock Policy which aim, among others, to establish breed improvement schemes to help improve the performance of indigenous/local livestock species (APD/MOFA, 2005).

The Sow-AnGR process has brought to the public attention the livestock sector of Ghana's Agriculture which hitherto had been overshadowed by activities in the crop sector. The first National Workshop on AnGR management was held in 2003 to educate the general public on sustainable management of AnGR. The NCC with support of the FAO and MOFA managed to produce and submit Ghana's Country Report (CR) in good time. The CR raised critical issues which informed policy makers the need to give attention to local AnGR. This period coincided with the launch in 2004 of a 6-year Livestock Development Project (LDP) by the Government of Ghana with funding from the African Development Bank (ADB). This project had a major component of developing of local/indigenous livestock breeds including

formation of breed associations. In all districts where the LDP is being implemented, livestock breed associations have been formed to encourage raising of local livestock species: Ashanti Black Pig, Ghana Shorthorn Cattle, White Fulani Cattle, Sanga Cattle, West African Dwarf Goats and Djallonke sheep. A priority area identified in Ghana's CR was the need to develop human resource in the area of AnGR management. The curricula of animal breeding in the country's universities are being revised to include topics on conservation and sustainable utilization of AnGR as well as biotechnology. This should help improve both the quality and quantity of people involved in AnGR management in the present and in the future. Ghana has actively participated in regional and sub-regional meetings on AnGR with the view to strengthening networks with other developing countries. Ghana is currently a member of the Intergovernmental Technical Working Group on AnGR.

Ghana has taken a bold step to be part of the global Sow-AnGR process. We call on our development partners to help by collaborating with us on various projects in AnGR, providing assistance to help Ghana train students and Post Docs in new areas of AnGR management such as the application of various molecular techniques to characterize AnGR. Finally support for the establishment of a permanent office for the management of AnGR in Ghana will be highly appreciated.

## Islamic Republic of Iran

*Mohammad Ali Kamali*

*National Co-ordinator for the management of AnGR*

The Iranian plateau with its geographical situation, extensive plains, climatic diversity and position as a junction point for west and east highways, provides the location for the gathering and movement of various livestock and poultry species. As a result, certain species of sheep, goats, poultry and cattle have developed a relatively desirable range of genetic diversities and enhanced the country's reputation as the home of authentic genetic stock. Iran is globally assumed to be one of the richest centers of diversified genetic resources, amounting to up to 12 000 plant species, of which 59 156 domestic and wild samples have been already recorded, as well as 26 breeds of sheep, 9 breeds of goat, 7 breeds of cattle, 7 breeds of horse.

The Islamic Republic of Iran also has experienced some genetic encroachment on native species by exogenous breeds which resulted in large scale genetic mixing and population decline, intensified by the non-economic production of native species. Rearing of some native species is no more economic mainly due to changes in market patterns or life styles which have led to decreased consumption of these species, and decreasing trends in their populations particularly in the case of cattle. This decreasing trend can also be seen in other species. In response to this situation several actions have initiated with the intention of harmonizing and organizing the inventories of AnGR in Iran as follows:

- Pursuant to relative perceptions voiced by national stakeholders on animal genetic conservation, tangible support in the form of technical, research and extension services were recently forwarded which may continue and increase in the future. In this respect, "The Law of Livestock Breeding Systems" was prepared by the Ministry of Jihad-e-Agriculture and presented to the Government for ratification. The law has resulted in the creation of the Ministry for the Conservation of Aquatic, Livestock and Poultry Genetic Resources.
- To date, the Act of National Veterinary Systems, which was laid down in 1971 and encompassed overall regulations on hygienic aspects of animal husbandry, still governs quarantine codes and the trans-boundary movement of native or exotic animal genetic resources. The act also covers the following measures under its domain:
  - Preventing and controlling animal diseases or common human and animal diseases.
  - Issuance of hygiene certificates for animals and related raw products for export.
  - Hygienic supervision of pastures, watering places, stables, and other breeding establishments.
  - Monitoring of feeding plants, slaughter houses and processing units.
  - Controlling the production, import, export and marketing process of various biologic materials e.g. drugs, vaccines, serums, etc.
- Development of AnGR databanks in *ex-situ* and *in-situ* forms for native cattle, camels, goats, horses, buffalo, sheep and poultry at a national level.
- Expanding biotechnology activities aimed at recognizing, conserving and preserving AnGR especially in poultry, sheep, horses, camels and cattle.
- Breeding and extension projects in poultry, cattle and sheep in order to improve the products of relevant species.

## Ireland

*Helen O'Toole*

*National Co-ordinator for the management of AnGR*

The management of animal genetic resources for food and agriculture in Ireland is co-ordinated by the Department of Agriculture and Food with the assistance of a National Advisory Committee. The Committee meets on an annual basis and provides funding to a range of projects that cover one or more of the primary policy objectives including; identification, evaluation and conservation of unique Irish Genetic Resources whose survival is being threatened or endangered, development and utilisation of genetic resources to increase national food security and the promotion of public awareness and support for genetic resources.

Arising from the recommendations from Ireland's Country Report the Advisory Committee has prioritised funding for the following actions:

- A National Conservation Strategy Plan was established to develop a long-term conservation plan for a number of endangered traditional livestock breeds. The plans include the national cross-cutting priorities as outlined in Ireland's Country Report. For example the development of an emergency reaction plan which can be invoked in the event of a disease outbreak, and
- the use of National Parks and State lands as a resource for the maintenance of indigenous breeds as a living gene-bank.
- Phenotypic, genetic and molecular characterisation of breeds was carried out on a number of endangered rare breeds and the results have been used in devising conservation plans.
- Ireland is participating in the EFABIS Net project ([www.eaap.org/content/efabis\\_net.htm](http://www.eaap.org/content/efabis_net.htm)) to assist with the development of a national database for all breeds of farm animals. Further work is required in this area to develop the capacities of breed societies to ensure the effective flow of the required information.
- *Ex-situ* conservation work has been carried out for a number of endangered breeds, however, a national gene-bank for these breeds has yet to be established.
- Ireland Rural Environmental Protection Scheme was modified in light of recommendations in Ireland's Country Report to encourage the greater uptake of measures for rare native breeds. Improvements to the measure have resulted in a greater level of participation and an increase in the number of animals that are eligible for support under the measure.

## Madagascar

*R. Rakotondravao*

*National Co-ordinator for the management of AnGR*

### Objectif:

Développement et sauvegarde des ressources génétiques animales pour la sécurité alimentaire.

### Les actions prioritaires:

1. La première action à entreprendre repose sur le développement de l'élevage de zébu malgache, cheptel le plus important. Il s'agit de mettre en place une bonne gestion de ces ressources par une bonne politique d'utilisation et par l'amélioration de sa performance par un programme de sélection.
2. En deuxième priorité, on doit faire un effort de conservation de la race «renitelo» par un croisement de retrempe.
3. La troisième action prioritaire porte sur la caractérisation de la race « Baria » et la mise en place d'un programme d'utilisation et de

conservation de cette race. Favoriser la domestication et la constitution de ferme d'élevage.

4. Améliorer également le système d'élevage des petits ruminants et leur utilisation.
5. L'élevage avicole villageois constitue une source de revenu et protéique au niveau du monde rural malgache. On doit renforcer les actions de promotion de ce type d'élevage et sa protection vis-à-vis des maladies. Continuer les actions de caractérisation des souches malgaches.
6. Mettre en place un système de formation spécialisée en ressources génétique animales pour renforcer la capacité de gestion des ressources.

## Union of Myanmar

*Nay Win*

*National Co-ordinator for the management of AnGR*

The Livestock Breeding and Veterinary Department under the Ministry of Livestock and Fisheries is the main organization concerned with making policy and management plans for the conservation and utilization of domestic animal genetic resources (AnGR).

The main priority actions for AnGR are:

- Research into the animal production systems of existing farm animals and local breeds.
- Promotion of *in-situ* conservation and the sustainable use of rare breeds.
- Raising public awareness and providing education regarding on-farm conservation.
- Developing a regulatory framework to promote and ensure the continuity of AnGR maintenance.

According to these priority actions, the Livestock Breeding and Veterinary Department has carried out following the activities:

- In accordance with the roles and values of AnGR, the Livestock Breeding and Veterinary Department has given training to farmers on conservation of AnGR encouraging a greater focus on draught cattle and village chicken breeds than other species. For the sustainable

use and development of AnGR in future, the breeding policy for domesticated animals like draught cattle, sheep, goats, indigenous pigs and poultry must be maintained at its present level and a monitored crossbreeding programme for all species included.

- *In-situ* conservation for indigenous chicken breeds (Inbyinwa Kyet, Sittagaung Kyet, Taikket Kyet, Lin da) in special farms in lower and upper Myanmar by the Livestock Breeding and Veterinary Department. For sustainable use and conservation of Mythan, the Myanmar Livestock and Fisheries Bank is giving loans to local farmers in northern and southern Chin State.
- For an integrated approach to improving livestock production using indigenous resources and conserving the environment, useful indigenous draft cattle like the Shwe Ni and Shan Bu which are declining in numbers, have been brought under a conservation programme in Magwe Division (Middle Myanmar) and southern Shan State.
- *Ex-situ* conservation using cryogenic preservation for Mythan (frozen semen straws) has been occurring since 1997 in the Artificial Insemination Centre at Yangon.

## Nigeria

*Lawrence A.O. Asije*

*National Co-ordinator for the management of AnGR*

Nigeria is richly endowed with very diverse domestic animals (cattle, sheep, goats, camels, donkeys, pigs and poultry) that are being developed and used widely for food and agriculture in the country. The predominant production system, nomadic pastoralism, is characterized by low inputs and productivity. Output in the industry has been low, a situation that led to the prioritization of enhanced management practices after the completion of *The Country Report on the State of the Animal Genetic Resources*.

Significant efforts made by the Government to ensure sustainable management of the country's animal genetic resources after completion of Country Report include:

1. Prioritization of Food Security and Poverty Alleviation Programmes in Nigeria.
2. Rehabilitation, expansion and restocking of existing animal genetic resources improvement and conservation centres in the country.
3. Provision of support for promotion of domestication and conservation of some feral relatives of the nation's AnGR (rabbits, grass-cutters, snails, etc).
4. Improvement and sustainable utilization of all national feed resources for use of farm animals.
5. Financial support to research institutes and universities of agriculture nation wide for research into various aspects of AnGR management, conservation and sustainable utilization.
6. Increased effort in the control of Trans-boundary Diseases (TADS), zoonotic and other diseases of economic importance, including Avian Influenza.
7. Accelerated development of grazing reserves, stock routes and grazing corridors and settlement and empowerment of pastoralists.
8. Putting in place policies in the areas of breeding, production, disease control, trade and animal product assurance, afforestation, prohibition of bush burning, establishment of parks, gardens, game and grazing reserves as well as stock routes that will ensure orderly and safe use of animal genetic resources in the country.

Nigerian firmly believes that prioritization of advanced production technologies and methodologies in critical areas like AI, ET, MOET, etc. will further enhance output per animal, conservation and sustainable utilization efforts. Sustainable utilization of animal genetic resources in the country will create jobs and income, and hence wealth. It will thus lead to poverty alleviation and facilitate achievement of food security. Consequently, the Government is ready to negotiate with any other government(s) and Non-governmental Organization(s) that is/are willing to assist her in these areas.

## Norway

*Nina Sæther*

*National Co-ordinator for the management of AnGR*

The most important action in Norwegian AnGR management during the last years is the establishment of The Norwegian Genetic Resource Centre in July 2006. The centre was established by the Ministry of Agriculture and Food as a department of the Norwegian Forest and Landscape Institute and promotes conservation and sustainable use of national genetic resources in farm animals, crop plants and forest trees. As the national centre of expertise on genetic resources in agriculture, it acts as advisory body to the Ministry of Agriculture and Food and coordinates a wide range of activities. Furthermore it is the secretariat for The Norwegian Genetic Resource Council and for advisory committees within each of the three sectors farm animals, crop plants and forest trees. Together with these bodies the Centre develops and conducts national programmes for conservation and sustainable use of genetic resources in agriculture. The Centre initiates and administers activities within the three sectors, and cooperates with gene conservation networks for practical implementation. It contributes towards public awareness and information flow on genetic resources and is the national participant in Nordic and international programmes.

Within the AnGR conservation programme, an action of major importance is maintaining the gene

bank for egg laying hens. This gene bank includes lines from the national breeding work on egg layers which was closed in 1995, and might be the only public gene bank for egg layers in the industrialized world. Monitoring native and small populations has been highly prioritized and subsidy systems for farmers keeping these breeds have been established in the period. For the commercial native breeds of cattle and pigs, export of genetic material has been established as a permanent part of the breeding associations' activities. The increased export activity has accentuated the need for international legal frameworks regarding exchange of genetic material from farm animals. This aspect is discussed in the Nordic project "Legal framework for the rights to and exchange of animal genetic resources", a project Norway is supporting and participating in. Sustainable breeding is fundamental in Norwegian breeding work – and the three national breeding associations GENO, NORSVIN and Norsk Sau og Geit (cattle, pigs and goat and sheep breeding associations respectively) have introduced from 2006 a new chapter in their annual reports with essential parameters from their populations to document the sustainability of their breeding work, such as genetic trends and effective population size.

---

## Sultanate of Oman

*Rashid Soud Al-Habsi*

*National Co-ordinator for the management of AnGR*

The Sultanate possesses many animal genetic resources (AnGR) living under varying, difficult environmental conditions. These AnGR have adapted well to these environments. The process of the preparation of the First Report on The State of the World's AnGR has stimulated interest in these resources.

Measures taken to protect AnGR are listed below

The state has had policies and strategies in place to limit the depreciation of AnGR, which are considered a national asset. Among these strategies are:

- Establishing animal profiles like that of the endangered Arabian Oryx.
- The Sultanate has joined the CBD.
- Remodeling the policies and strategies of research establishments to cater for the monitoring and characterization of livestock species.
- Decreasing the camel stocking rate in the south of the Sultanate to maintain the pasture quality.
- Holding seminars for upper management on sustainable development, protection of AnGR, encouraging investment in the development of AnGR and national training on AnGR management



---

## Papua New Guinea

*Siva Supiramaniyam*  
*National Co-ordinator for the management of AnGR*

Following the preparation of Papua New Guinea's Country Report on the State of Farm Animal Genetic Resources in November, 2004 there has been little progress on the proposed action plan mainly due to lack of financial resources and other unforeseen delays.

The Ministry of Agriculture and Livestock has recently formulated a National Agriculture Development Plan (2007 – 2016) with technical and financial assistance from FAO. This plan has been formerly approved by the National Government of Papua New Guinea in March 2007. Implementation of this plan is expected to commence in the second half of 2007.

Conservation of farm animal genetic resources is one of the activities that have been identified for implementation under this plan and will receive budgetary support from the National Government of Papua New Guinea. As indicated in the country report National Agriculture Research Institute of

Papua New Guinea is mandated to implement the action plan proposed in the Country Report.

It must be emphasized that within the foreseeable future there is no threat to any of the AnGR in Papua New Guinea. The only exception to this is the Javanese Zebu cattle that is considered as endangered. The basic information including the number and location of different farm animals in Papua New Guinea is currently not available. Therefore, a survey has been proposed in the country report to assemble this information. This survey will now be combined with the proposed National Agricultural Census, to be conducted in 2008 under the National Agriculture Development Plan. This information is vital to refine the action plan and prioritize activities that have been highlighted in country report, especially to develop appropriate national policies to safeguard the AnGR.

## Poland

*Elzbieta Martyniuk*

*National Co-ordinator for the management of AnGR*

The preparation of the Country Report supported the introduction of a new paragraph (§21a), specifically devoted to the conservation of animal genetic resources, as part of the process of amending the Law on the Organization of Breeding and Reproduction of Farm Animals in 2004.

During the last few years, several new initiatives have been undertaken to restore native breeds. The first has already proved successful with regards to Polish White-backed cattle, the others include restoration of the Carpathian goat, the Podhalanian Zackiel and the old-type Polish Merino as well as traditional cold-blooded horse breeds such as the Sokolski and Sztumski.

Changes in the livestock production system resulted in an urgent need to undertake several new conservation programs to address the continuously decreasing pre-bred populations of two native horse breeds. These programs, applied to the Malpolski and Silesian horse, led to development of relevant conservation programs in 2004. A similar situation was observed in the Wielkopolski horse breed.

The continuous increase of the Holstein genotype in the Polish dairy cattle population resulted in the introduction of Polish red and white and Polish black and white dual purpose cattle breeds into a conservation program in 2007. There are also efforts to include several coloured varieties

of nutria and two additional lines of carp in conservation programs in 2007.

The support for AnGR conservation is provided through the Agri-environmental Program (for breeds of cattle, horse, sheep and pig) and from the state budget for breeds of remaining species (poultry, fur animals, fish and honey bees). To ensure a timely and professional service for breeders participating in the conservation of native breeds, the Animal Genetic Resources Conservation Unit was established in the National Research Institute of Animal Production in Balice in January 2005. At present, nine specialists are responsible for supervising the implementation of conservation programs for each species or group of species, and for interactions with breeders.

In last several years special exhibitions of native breeds, accompanied by seminars and occasional publications have been organized during the National Animal Show POLAGRA-FARM. In 2006, an album of Polish native breeds was published and distributed during POLAGRA. To support AnGR activities and facilitate preparation for the Interlaken ITC, in May 2007, an international scientific conference entitled "Conservation of Animal Genetic Resources in Poland and in Europe - achievements and dilemmas" was held in Balice.

## Serbia

*Srdjan Stojanovic*

*National Co-ordinator for the management of AnGR*

The most important issues related to the preparation of the Country Report are:

1. Serbia has signed and ratified the CBD
2. Serbia has been nominated for the NFP
3. Serbia has established NCC

Main priority actions undertaken since 2002 were the following:

1. Identification of endangered breeds of domestic animals.

2. Ongoing work on updating the National AnGR database.
3. Financial support to the stakeholders of AnGR.
4. Increasing collaboration with countries in the region.
5. Increasing collaboration with research institutes, NGO's and international organisations.
6. Provision of financial support for different projects related to AnGR.
7. Support the developing production of local products and agro-tourism in protected areas.

---

## Slovak Republic

*Ladislav Hetényi*  
*National Co-ordinator for the management of AnGR*

The following are the main actions taken in Slovak Republic in the field of AnGR management:

- Developing the national inventory on farm animal biodiversity and breed characterization and conducting regular monitoring of farm animal genetic resources.
- Involving farm animal genetic resources in agro-tourism and the non-profit sector.
- Finding the balance between market demand and the production potential of traditional breeds.
- Managing farm animal genetic resources in accordance with the principles of sustainability, environmental impact and ethological needs.
- Improving the legal framework for farm animal genetic resources and building their capacities.
- Improving public awareness and dissemination of research results in the field of farm animal genetic resources.

## Spain

*Isabel García Sanz*

*National Co-ordinator for the management of AnGR*

During 2006, the Ministry of Agriculture, Fishing and Feeding (MAPA) made progress in the development of the National Strategic Plan for the Conservation, Improvement and Promotion of Zoogenetic Resources, in coordination with livestock breeders' associations and the Autonomous Communities (Spanish regions), within the framework of the New Communitarian Agrarian Policy and the FAO strategy.

Actions were undertaken to complete the current analysis of resources, and make adjustments to the administrative and technical sources utilised as part of the implementation process, in line with directives from FAO, in the following ways.

### **Inventory, characterization and classification of breeds**

1. Development of the Official Catalogue of Spanish's breeds. In the Official Catalogue all the livestock breeds that are zootechnically regulated and supported have been inventoried. Currently there are 169 catalogued breeds.
2. Definition of prototypes and characterization: The prototypes of most of the breeds have been approved and published, with the regulation of the genealogical book.
3. Recognition of associations of breeders of bovine, ovine, goat, pig, canine, poultry and equine species, for the purposes of the management of genealogical books, and the development of breeding programs with 159 associations.
4. Appointment of breeds inspectors to supervise the associations' functions.
5. Individual identification and inscription of the animals in the genealogical book and the registry of collaborating farms, with 2.8 million registered reproducing females.

### **Programs of breeding (conservation or improvement) and sustainable use**

1. Approval of national programs, general and specific for each breed.
2. Reproducers valuation and animal qualification.
3. Yields control and genetic evaluation, including criteria for ovines against TSE, with 1 555 000 genotyped ovines (National Genotyping Program).
4. Authorization of Testing Centers.
5. Sustainable use of and alternatives for the employment of the breeds and their products using quality identifiers, country tourism, etc

### **Animal reproduction and genetics**

1. Authorization of collection, storage and reproduction centers and germplasm banks. At the moment, there are 19 centers for bovine species, 15 for ovine and goat species, 46 for pigs and 17 for equines, and 25 processes for the collection of bovine embryos, 3 for equines and 1 for ovine and goat embryos.
2. Designation of the Reproducing Reference Center or National Bank (in Madrid).
3. *Ex-situ* conservation of breeds in danger.
4. Artificial insemination, and diffusion of the improvement created with high genetic value semen.
5. Authorization of genetic laboratories, DNA banks and filiation control; providing the Central Veterinary Laboratory (Algete) with proper sources.

## Programs for the institutional development, coordination and creation of capacity

1. Organization of meetings, in committees, with all the partners implied in the management of breeds, both public and private.
2. Creation of communications networks and opportunities for the exchange of information, with national (Universities, INIA) and international (EAAP, FAO, EU) organisations.
3. Connection of policies and programs on animal genetics resources with other national and international initiatives in the fields of agriculture and biodiversity.
4. Educative programs for vets, livestock breeders and the general public.
5. Establishment of a legal framework including norms and policies. There are already legal norms and two Royal Decree projects exist to develop these programs.

## Information

1. Dissemination of information through the Internet (Web pages, such as PEGASO for equine breeds) and awareness campaigns of and promotions, particularly the congress FUTUREQUI, in the first half of 2007.
2. Plan for export, commercialization and international cooperation (Creation of the web CEXGAN).

## Creation of the national computer science system

Coordinating references to pure breed animals registered in genealogical books between different data bases.

## Financing

Financing the program with national and European funds. It has been subsidized, and properly structured in the regulating legislation that is now being enacted.

## Sweden

*Eva-Marie Stalhammar*

*National Co-ordinator for the management of AnGR*

- Setting up a national committee on AnGR which is advisory to the competent authority in matters concerning conservation, sustainable utilizing and developing of Swedish AnGR. The committee has worked since 2005.
- Amending the National Act and Ordinance for Livestock, etc management June 2006. A new aim was included: Promoting a sustainable management of AnGR. This addition gives the competent authority, the Swedish Board of Agriculture, the possibility to further regulate the management of AnGR towards the responsible actors such as breeding organisations.
- An Action plan for AnGR is under way. This plan will prioritize between the actions needed for conservation, use and development. The plan will give an idea of costs and also have a time plan.
- Starting a conservation project to get hold of the former dairy breed Swedish Friesian (SLB) before the Holstein breed was introduced into the Swedish population. This project has started from a farmer's appeal to save /"rescue" what is left of the this breed which used to be one of the numerous dairy breeds in Sweden. The older breed was more multi purpose than today's Holstein breed.

## Viet Nam

*Nguyen Vang Dang*  
National Co-ordinator for the management of AnGR

In terms of policy and management:

- The National Assembly has issued a national management decree for livestock breeds, consisting of national management documents regarding:
  - Strategies, management and usage of AnGR.
  - Research into selecting, creating, experimenting with and approving new animal breeds.
  - Production of and business dealings related to, animal breeds.
  - Management of livestock breed quality, directly managed and operated by the MARD.
- The Ministry of Natural Resources and Environment, in coordination with other ministries has establish the Law of Biological Diversity to be presented to the Government at the end of 2007, in which the importance of FAnGR are highlighted.
- The Government has increased the budget for the animal genetic conservation program from US\$35 000 to US\$100 000 per year.
- The biotechnical program has been improved, within which the most important project of the Ministry of Agriculture and Rural Development is concerned with using molecular techniques to analyse the animal genetic resources of local chicken breeds such as the Ri, Mia, Ho breeds.

In terms of national activities

- Publishing the completed data system including:
  - Three monographs of genetic resource conservation, one atlas of domestic animals and many publications involving the management, conservation and usage of FAnGR.
  - The establishment of a website and database system concerned with the preservation of the biological diversity of domestic and wild animals in Vietnam in the information centre at the Ministry of Science and Technology

- Enhancing the analysis of animal genetic resources including:
  - The molecular genetics laboratory in Vietnam using microsatellite techniques to determine Vietnam cattle, chicken, pig and goat genetic resources.
  - The biological research program coded KC 04-03 in which molecular genetic techniques were used to improve the productivity of Vietnamese pigs and cattle. Thirty gene sequences involving traits such as productivity and quality of pork and milk in Vietnam have been approved and proclaimed at the International Genbank. (EMBL/Genbank/DDBJ: [www.ebi.ac.uk](http://www.ebi.ac.uk), [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
- Approaching the market and exploiting several local livestock breeds which have economic benefits such as the H'mong chicken, sheep, goats and Ban pigs. Some breeds are conserved and exploited via culture and tourism through women's, elders' and gardeners' associations; worship ceremonies; Ho chicken and buffalo competitions; elephant and horse riding festivals; etc.
- Strengthening capacity and information exchange by:
  - The Vietnamese Government improving the equipment available to animal cell laboratories for analyzing AnGR in Vietnam.
  - Improving technological training for researchers through coordinated biological diversity research projects such as Biodiva and IAEA.
  - Regularly and efficiently updating helpful information networks for the management and usage of genetic resources from DAD-IS at FAO.

---

## Managing Biodiversity in Agricultural Ecosystems

D. I. Jarvis, C. Padoch & H. D. Cooper (Eds)

Columbia University Press, New York, USA

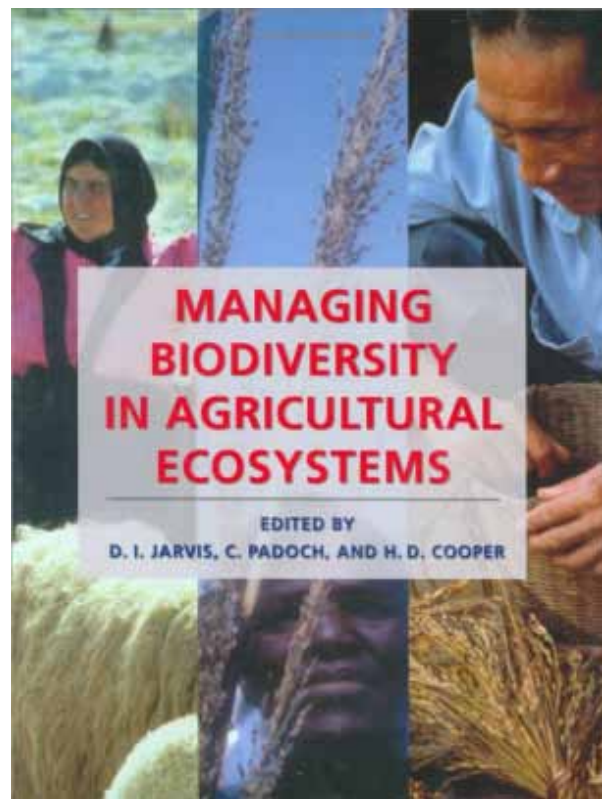
Published in 2007, pp. 105

ISBN: 9778-0-231-1364-8

This hardcover book takes a look at how farmers manage, maintain, and benefit from biodiversity in agricultural production systems. The volume includes the most recent research and developments in the maintenance of local diversity at the genetic, species, and ecosystem levels. Chapters cover the assessment and farmer management practices for crop, livestock, aquatic, and associated diversity (such as pollinators and soil microorganisms) in agricultural ecosystems; examine the potential role of diversity in minimizing pest and disease pressures; and present studies that exemplify the potential nutritional, ecosystem service, and financial values of this diversity under changing economic and environmental conditions. The volume contains perspectives that combine the thinking of social and biological scientists.

Inappropriate or excessive use of inputs can cause damage to biodiversity within agricultural ecosystems and compromise future productivity. This book features numerous case studies that show how farmers have used alternative approaches to manage biodiversity to enhance the stability, resilience, and productivity of their farms, pointing the way toward improved biodiversity on a global scale. As custodians of the world's agricultural biodiversity, farmers are fully invested in ways to create, sustain, and assist in the evolution and adaptation of a variety of plant and animal species. Thus this text is mandatory reading for conservationists, environmentalists, botanists, zoologists, geneticists, and anyone interested in the health of our ecosystem.

Assembling the efforts and expertise of a diverse and well-qualified set of authors, this book addresses a wide range of topics, yet the essays clearly cohere. The perspective is global, which will make the book the single most authoritative source to date on issues of agrobiodiversity.



---

## **Marker-Assisted Selection: Status and Future Perspectives in crops, Livestock, Forestry and Fish**

**E.P. Guimarães, J. Ruane, B.D. Scherf, A. Sonnino & J.D. Dargie (Eds)**

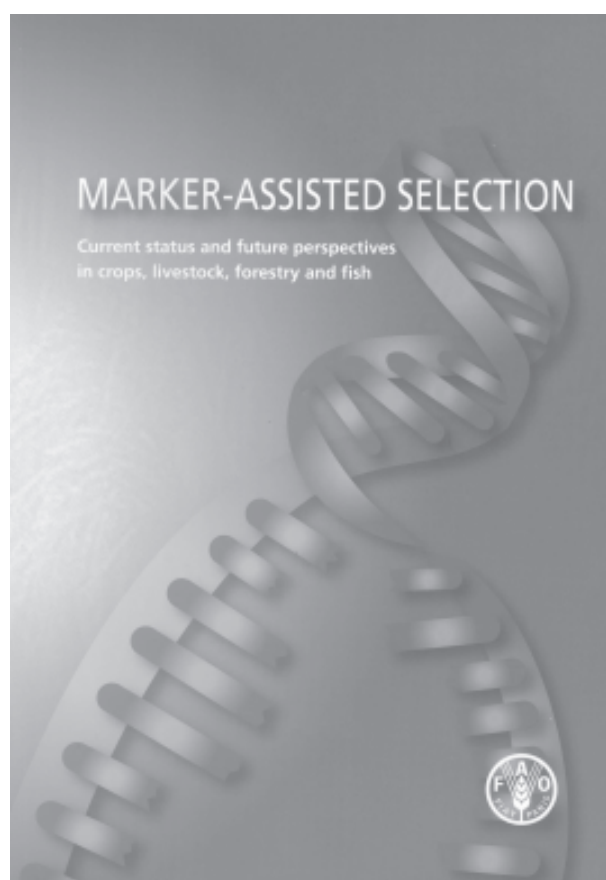
**FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy**

**Published in 2007, pp. 471**

**ISBN: 978-92-5-105717-9**

The 22-chapter book includes a series of case studies giving a comprehensive technical description and assessment of the current use of Marker Assisted Selection (MAS) and concludes with a series of 5 chapters devoted to non-technical issues relevant to applications of MAS in developing countries, such as national research capacities and international partnerships, economic considerations, the impacts of intellectual property rights, and policy considerations. The 46 contributors to the book were all internationally recognised experts in their field and came from 26 different organisations (comprising universities, national research organisations, CGIAR centres, UN agencies and private companies) and 15 different countries.

At present the book is published in electronic format only and may be viewed on the web at: [www.fao.org/docrep/010/a1120e/a1120e00.htm](http://www.fao.org/docrep/010/a1120e/a1120e00.htm).





## People and Animals - Traditional Livestock keepers: Guardians of Domestic Animal Diversity

K.-A. Tempelman & R.A. Cardellino (Eds)

FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy

Published in 2007, pp. 123

ISBN: 978-92-5-105684-4

This soft cover book deals with the domestic animal diversity that is being lost at an alarming rate. Worldwide, local livestock breeds are being crossed or replaced with higher-yielding animals under the motto "exotic is better". Furthermore, the native habitats of pastoralists and their animals are steadily disappearing, relinquishing their domain to agriculture, protected nature reserves and industrial activities. This trend is further encouraged by existing formal policy, short-term profit opportunities and a decreasing appreciation of the value of Local breeds.

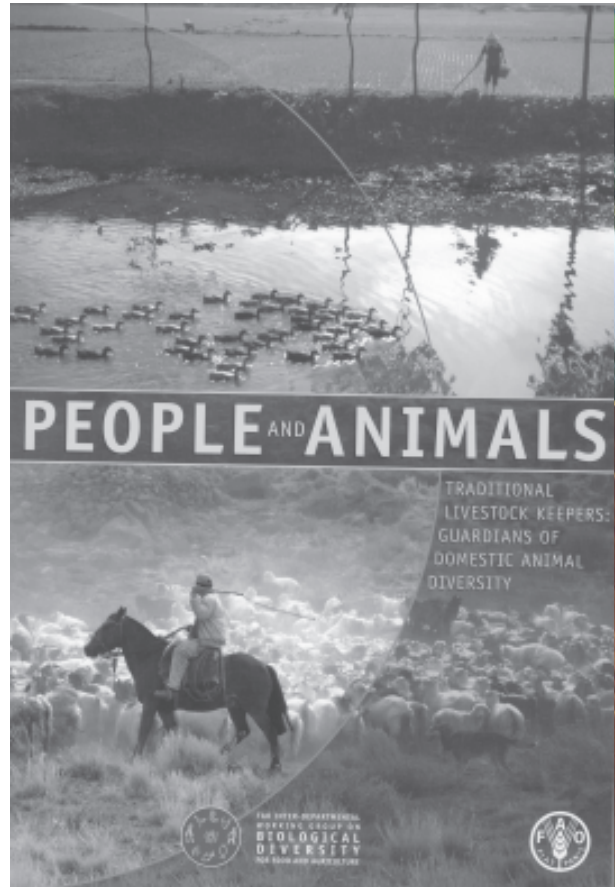
This book presents a variety of farm animal species and breeds that are the result of centuries of local knowledge-based selection by traditional livestock keepers. Through traditional farming systems a broad diversity of livestock breeds is being preserved and developed to provide meat, dairy products, eggs, fibre, fertilizer, manure and draught power. Finally, the book presents livestock diversity as a tool for future capacity to meet unforeseen needs and opportunities.

Case studies on traditional livestock farming systems using local breeds were compiled in order to understand and establish:

- How communities manage local animal genetic resources.
- Local knowledge and good practices.
- How animal genetic resources interact with their environment.
- How communities cope with threats to their local animal genetic resources.
- Long-term solutions and sustainability of strategies.

The main lessons to be drawn from the case studies are:

1. Technical and political decision-makers are often unaware of the far-reaching impact of their decisions on the conservation and sustainable use of livestock genetic diversity; consequently, raising awareness and teaching are essential elements.
2. Communities in general have identified the challenges they face in making their farming systems profitable enough to support their



livelihoods. Such knowledge should be consolidated by decision-makers, who have huge potential to contribute to solving problems related to the loss of livestock diversity faced by farming communities.

3. Connecting people with others who have already addressed, or are addressing, similar problems generates new ideas and solutions. It also empowers people to formulate solutions serving both their own and common situations and to take appropriate action.

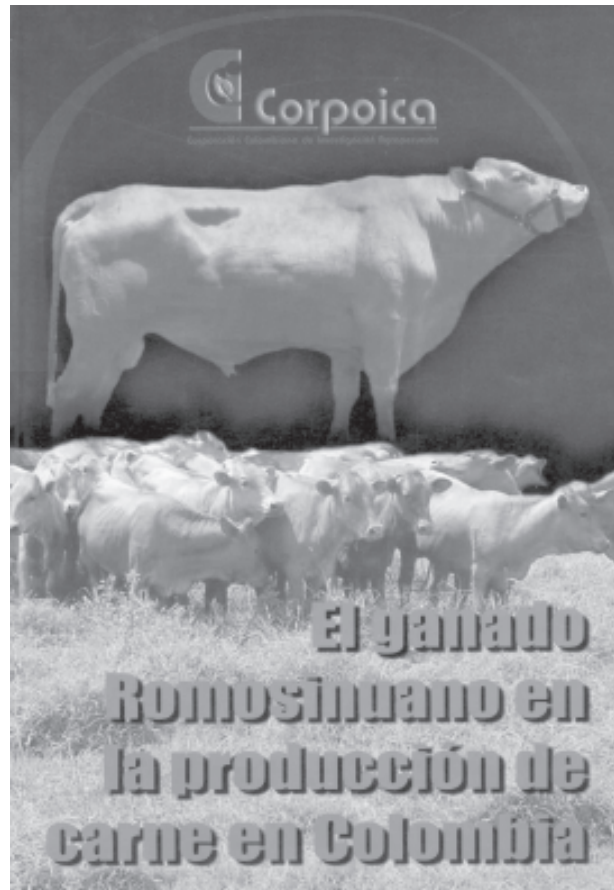
**El Ganado Romosinuano en la  
produccion de carne en Colombia**  
**The Romosinuano cattle in Colombian meat production**  
**(In Spanish)**

**R. Rodrigo Vázquez, S. Rodrigo Martínez, Ch. Hugo Ballesteros,  
L. Grajales Henry, G.J. Esteban Pérez & P. Yesid Abuabara (Eds)**  
**CORPOICA, Mosquera (Cundimarca), Colombia**  
**Published in 2006, pp. 102**  
**ISBN: 978-958-8311-10-4**

This soft cover book describes recent works in conservation, characterization and promotion in the Colombian Creole cattle Romosinuano. Initially, a brief historical review of the breed is illustrated, as well as its geographic distribution in Colombia, the effects its effects on the Colombian beef production.

In the second part of the book several characterization studies are presented together with morpho-metric studies, genetic evaluations, productive and reproductive characterizations and a compilation of results of studies on meat quality in Romosinuano, Zebu and their respective crosses. The publication also displays all activities related with conservation and promotion of this breed and it ends with a review of productive and reproductive performance of Romosinuano breed in subtropical areas.

For sure, this publication may be useful to producer, veterinarians and students with interest in this geographic area and with its production systems.



**Patrones tecnológicos y calidad de la carne bovina en el caribe colombiano**

**Technologies patterns and meat quality in the Colombian Caribe**

**(In Spanish)**

**R. Rodrigo Vázquez, H.J. Pulido, P.Y. Abuabara, S. Rodrigo Martínez, S.B. Abadía, L.C. Arreaza, J.Z. Silva, L.S. Sáncz, Ch. Hugo Ballesteros, C. Muñoz, T. Rivero, A. Nivia & G. Barrera (Eds)**  
**CORPOICA, Mosquera (Cundimarca), Colombia**

**Published in 2005, pp. 93**

**ISBN: 958-8210-82-8**

This soft cover publication is the result of a project supported by Colciencias, FEDEGAN and CORPOICA.

Its objective is to illustrate the current situation of meat production in Colombia, the local expectatives, areas with higher productive potential and applied technologies in order to gain a higher quality production. The publication also includes a characterization study of meat quality in Colombia, considering some aspects like fat quality, tenderness and microbiological quality; it also describes several novelty tools to estimate meat quality.

Clear pictures and diagrams help the reader in following the clear presentation of the topics, resulting the publication of particular interest to meat technologists, students and industry responsables in meat processing.



## Development of animal identification and recording systems for veterinary surveillance and livestock development in countries of Eastern Europe

R. Pauw, A. Speedy & J. Mäki-Hokkonen (Eds)  
 Proceedings of the ICAR/FAO Seminar  
 held in Kuopio, Finland, on 6 June 2006  
 ICAR, Via G. Tomassetti 3, 00162 Rome, Italy  
 Published in 2007, pp. 130  
 ISBN: 92-95014-04-9; ISSN: 1563-2504

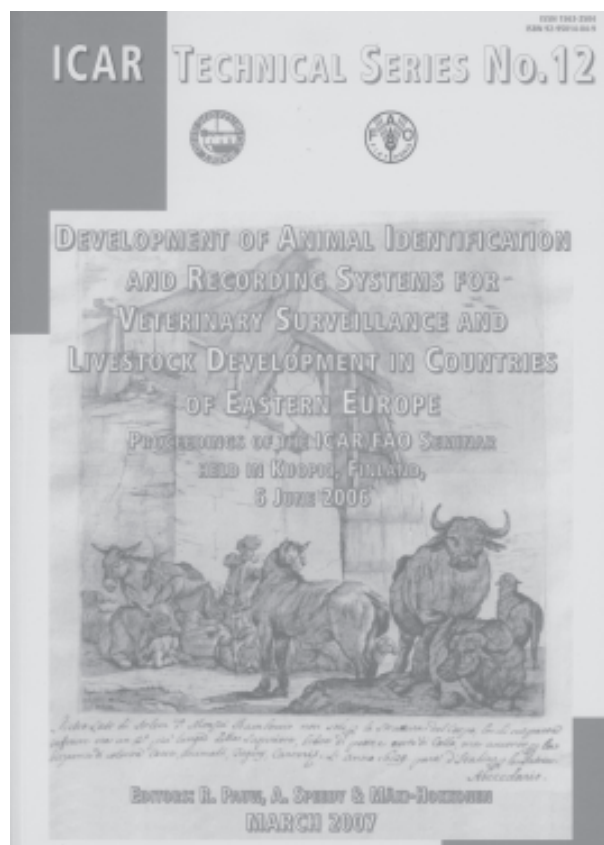
There is an increasing interest worldwide in animal identification and recording (I&R) systems including developed countries, countries in transition and developing countries. Traditionally, I&R systems were mostly developed as an essential element in breed improvement programmes and have been fundamental to the establishment and maintenance of livestock breeding programs

It is this increasing interest to develop and lay sustainable foundation for I&R systems, that resulted in FAO and ICAR together with OIE and the Government of Finland collaborating to put on a seminar at the 35<sup>th</sup> ICAR Session, held in Kuopio, Finland, in June 2006 entitled «Development of animal identification and recording systems for veterinary surveillance and livestock development in countries of Eastern Europe».

The parties of this seminar were convinced that in these countries appropriate systems to trace back the origin of animals and the food of animal origin are the natural and necessary entry point to food safety and security as well as contribution to sustainable livestock development. The basic prerequisites for an efficient I&R remain the same:

- A system that is practical and meets its expectations.
  - A system that is supported by an appropriate policy and legal framework of a country as well as by the producers and trade.
  - A system that is sustainable and self supporting.
- The seminar provided an overview of the role played by the ICAR Sub-Committee Animal Identification and its use by ICAR members.

The FAO paper on veterinary surveillance and livestock development issues in Eastern Europe stressed the priority of I&R for animal health,



particularly surveillance and control of BSE, FMD and CSF in the Region, and the need for an international standards. Further papers were presented by the European Commission on EU legislation, and by OIE on CIE activities and standards relating to I&R and traceability.

Freely available at: [www.icar.org/pages/Publications/technical\\_series.htm](http://www.icar.org/pages/Publications/technical_series.htm)

# The State of the World's Animal Genetic Resources for Food and Agriculture

B. Rischkowsky & D. Pilling (Eds)

FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy

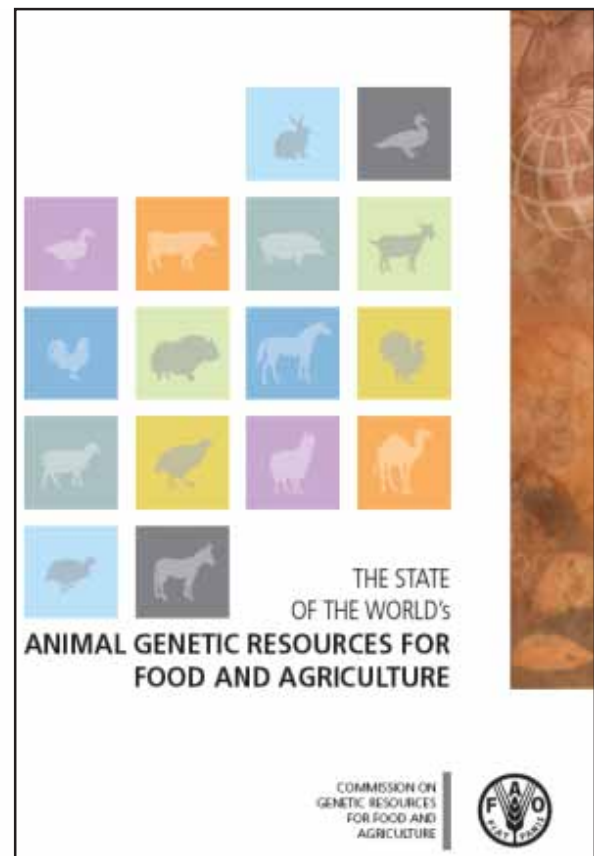
Published in 2007, pp. 552

ISBN 978-92-5-105762-9

Sustainable management of the world's livestock genetic diversity is of vital importance to agriculture, food production, rural development and the environment. *The State of the World's Animal Genetic Resources for Food and Agriculture* is the first global assessment of these resources. Drawing on 169 Country Reports, contributions from a number of international organizations and 12 specially commissioned thematic studies, it presents an analysis of the state of agricultural biodiversity in the livestock sector – origins and development, uses and values, distribution and exchange, risk status and threats – and of capacity to manage these resources – institutions, policies and legal frameworks, structured breeding activities and conservation programmes. Needs and challenges are assessed in the context of the forces driving change in livestock production systems. Tools and methods to enhance the use and development of animal genetic resources are explored in sections on the state of the art in characterization, genetic improvement, economic evaluation and conservation.

The main findings of the report are summarized in *The State of the World's Animal Genetic Resources for Food and Agriculture – in brief*. Arabic, Chinese, English, French, Russian and Spanish versions can be found on the attached CD-ROM and are also available separately in printed form.

As well providing a technical reference document, the country-based preparation of *The State of the World* has led to a process of policy development and a *Global Plan of Action for Animal Genetic Resources*, which once adopted, will provide an agenda for action by the international community.





## Editorial Policies and Procedures

The mission of the Animal Genetic Resources Information Bulletin (AGRI) is the promotion of information on the better use of animal genetic resources of interest to food and agriculture production, under the Global Strategy for the Management of Farm Animal Genetic Resources. All aspects of the characterization, conservation and utilization of these resources are included, in accordance with the Convention on Biological Diversity. AGRI will highlight information on the genetic, phenotypic and economic surveying and comparative description, use, development and maintenance of animal genetic resources; and on the development of operational strategies and procedures which enable their more cost-effective management. In doing this AGRI will give special attention to contributions dealing with breeds and procedures capable of contributing to the sustainable intensification of the world's medium to low input production environments (agro-ecosystems), which account for the substantial majority of the land area involved in livestock production; the total production of food and agriculture from livestock; and of our remaining farm animal genetic resources.

Views expressed in the paper published in AGRI represent the opinions of the author(s) and do not necessarily reflect those of the institutions which the authors are affiliated, FAO or the Editors.

The suitability of manuscripts for publication in AGRI is judged by the Editors and reviewers.

## Electronic publication

AGRI is available in full electronically on the Internet, in addition to being published in hard copy, at:  
<< <http://www.fao.org/dad-is>>>

## Types of Articles

The following types of articles are published in AGRI.

### Research articles

Findings of work on characterization, conservation and utilization of farm animal genetic resources (AnGR) in well described production environments, will be considered for publication in AGRI. Quality photographs of these genetic resources viewed in the primary production environment to which they are adapted, accompanying the manuscripts are encouraged.

### Review articles

Unsolicited articles reviewing agro-ecosystems, country-level, regional or global developments on one or more aspects of the management of animal genetic resources, including state-of-the-art review articles on specific fields in AnGR, will be considered for publication in AGRI.

### Position papers

Solicited papers on topical issues will also be published as deemed required.

### Other published material

This includes book reviews, news and notes covering relevant meetings, training courses and major national, regional and international events and conclusions and recommendations associated with the outcomes of these major events. Readers are encouraged to send such items to the editors.

## Guidelines for Authors

### Manuscript submission

Manuscripts prepared in English, French or Spanish with an English summary and

another summary in either French or Spanish, should be submitted to AGRI Editor, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy. Additionally the manuscript must be sent as a WinWord Electronic Mail attachment to [agri-bulletin@fao.org](mailto:agri-bulletin@fao.org). Photographs, coloured or black and white, and figures must be always sent by mail.

Manuscripts should be typed double-spaced and with lines numbered in the left margin. All pages, including those of references, tables etc., must be consecutively numbered. The corresponding author is notified of the receipt of a manuscript.

For manuscripts that are accepted after revision, authors are encouraged to submit a last version (3½" disc format) in Word 6.0 for Windows of their revised manuscript along with the printed copy.

#### *Preparation of the manuscript*

The first page of the manuscript must include the running head (abbreviated title), title, names of authors, institutions, full addresses including postal codes and telephone number and other communication details (fax, e-mail, etc.) of the corresponding author. The running head not exceeding 45 characters plus spaces, should appear at the top of page 1 of the manuscript entirely in capital letters. The title of the manuscript is typed in upper and lower case letters. The title should be as brief as possible not exceeding 150 characters (including spaces) with species names when applicable. Authors, institutions and addresses are in upper and lower case italics. There is one blank line between the title and the authors. Addresses are typed as footnotes to the authors after leaving one blank line. Footnotes are designated numerically. Two lines are left below the footnotes.

#### *Headings*

Headings of sections, for example Summary, Introduction, etc., are left-justified. Leave two blank lines between addresses footnotes and Summary and between the heading Summary

and its text. Summary should not exceed 200 words . It should be an objective summary briefly describing the procedures and findings and not simply stating that the study was carried on such and such and results are presented, etc. Leave one line between the summary text and Keywords which is written in italics as well as the keywords themselves. All headings of sections (14 regular) and sub-sections (12 regular) are typed bold and preceded and succeeded by one blank line and their text begins with no indentation. The heading of a sub-subsection is written in italics, and ends with a dot after which the text follows on the same line. Keywords come immediately after the summaries. They should be no more than six, with no "and" or "&".

#### **Tables and figures**

Tables and figures must be enclosed with the paper and attached at the end of the text according their citation in the document. Photos will not be returned

#### *Tables*

Tables, including footnotes, should be preceded and succeeded by 2 blank lines. Table number and caption are written, above the table, in italics (12) followed by a dot, then one blank line. For each column or line title or sub-title, only the 1st letter of the 1st word is capitalized. Tables should be numbered consecutively in Arabic numerals. Tables and captions should be left justified as is the text. Use horizontal or vertical lines only when necessary. Do not use tabs or space-bar to create a table but only the appropriate commands.

#### *Figures*

Figures including titles and legends should be preceded and succeeded by two blank lines. Figure number and title are written, below the figure, in italics (12) and end with a dot. The term figures includes photos, line drawings,



maps, diagrams etc.

All the submitted diagrams, must be accompanied with the original matrix of the data used to create them. It is strongly advised to submit diagrams in Word 6.0 or Excel 5.0. Figures should be numbered consecutively in Arabic numerals.

## References

Every reference cited in the text should be included in the reference list and every reference in the reference list should have been mentioned in the text at least once. References should be ordered firstly alphabetically by the first author's surname and secondly by year.

- Example for reference in a periodical is: Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10, 53-64.
- When there are more than one author: Matos, C.A.P., D.L. Thomas, D. Gianola, R.J. Tempelman & L.D. Young. 1997. Genetic analysis of discrete reproductive

traits in sheep using linear and nonnlinear models: 1. Estimation of genetic parameters 75, 76-87.

- For a book or an ad hoc publication, e.g., reports, theses, etc.: Cockrill, W.R. (Ed.). 1994. *The Husbandry and Health of the Domestic Buffalo*. FAO, Rome, Italy, pp 993.
- For an article in the proceedings of a meeting: Hammond, K. 1996. FAO's programme for the management of farm animal genetic resources. In C. Devendra (Ed.), *Proceedings of IGA/FAO Round Table on the Global Management of Small Ruminant Genetic Resources*, Beijing, May 1996, FAO, Bangkok, Thailand, 4-13.
- Where information included in the article has been obtained or derived from a World Wide Web site, then quote in the text, e.g. "derived from FAO. 1996" and in the References quote the URL standard form: FAO. 1996. *Domestic Animal Diversity Information System*, <http://www.fao.org/dad-is/>, FAO, Rome, Italy.

For all future manuscript dispatch and correspondence regarding  
AGRI, please use the following mailbox:

[agri-bulletin@fao.org](mailto:agri-bulletin@fao.org)

Thanks for the collaboration

## Normes et règles éditoriales

L'objectif du Bulletin d'information sur les ressources génétiques animales (AGRI) est la vulgarisation de l'information disponible sur la meilleure gestion des ressources génétiques animales d'intérêt pour la production alimentaire et agricole, d'après les recommandations de la Stratégie mondiale pour la gestion des ressources génétiques des animaux domestiques. Tous les aspects relatifs à la caractérisation, la conservation et l'utilisation de ces ressources seront pris en considération, suivant les normes de la Convention pour la Biodiversité.

AGRI désire diffuser de l'information sur la génétique, les enquêtes phénotypiques et économiques et les descriptions comparatives, l'utilisation et la conservation des ressources génétiques animales, ainsi que toute information sur le développement de stratégies opérationnelles et de normes qui puissent permettre une meilleure gestion de la relation coût/efficacité. C'est pour cela que AGRI prendra spécialement en considération toutes les contributions référées aux races et aux normes capables de permettre une intensification durable des milieux (agroécosystèmes) à revenus moyens et bas dans le monde; qui comprennent la majeure partie des terres consacrées à l'élevage, à la production totale des aliments et l'agriculture provenant de l'élevage; et tout ce qui reste comme ressources génétiques des animaux domestiques.

Les opinions exprimées dans les articles publiés dans AGRI appartiennent seulement aux auteurs et donc ne représentent pas nécessairement l'opinion des instituts pour lesquels ils travaillent, la FAO ou les éditeurs.

L'opportunité ou non de publier un article dans AGRI sera jugée par les éditeurs et les réviseurs.

## Publication électronique

En plus de sa version imprimée, la version totale de AGRI se trouve disponible sur Internet, sur le site:

<http://www.fao.org/dad-is/>

## Types d'articles

Les articles suivants pourront être publiés sur AGRI:

### Articles de recherche

Seront prises en considération pour leur publication sur AGRI les études sur la caractérisation, la conservation et l'utilisation des ressources génétiques des animaux domestiques (AnGR) accompagnées d'une bonne description du milieu. On encourage les auteurs à envoyer des photographies de bonne qualité qui montrent les races en question dans leur milieu naturel de production.

### Révisions

Occasionnellement, des articles contenant une révision des agroécosystèmes, au niveau national, régional ou mondial, avec un ou plusieurs aspects se rapportant à la gestion des ressources génétiques animales, y compris les mises à jour des différentes zones de AnGR, seront pris en considération.

### Articles spécifiques

Ponctuellement, des articles sur des thèmes spécifiques pourront être demandés pour la publication d'éditions spéciales.

### Autre matériel pour publication

Ceci comprend la révision de livres, nouvelles et notes de réunions importantes, cours de formation et principaux événements nationaux, régionaux et internationaux; ainsi que les conclusions et recommandations par rapport aux objectifs de ces principaux événements. Les auteurs sont priés d'envoyer ce genre de matériel aux éditeurs.

## Guide pour les auteurs

### Présentation du manuscrit

Les articles se présenteront en anglais, français ou espagnol, avec un résumé en anglais et sa traduction en français ou en espagnol; ils seront envoyés à l'éditeur de AGRI, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italie. En outre, l'article devra être envoyé par courrier électronique comme document attaché en version WinWord à *agri-bulletin@fao.org*. Les photographies, en couleur ou en blanc et noir, seront toujours envoyées par courrier normal.

Les manuscrits se présenteront à double interligne et avec le numéro correspondant à chaque ligne sur la marge gauche. Toutes les pages seront numérotées, y compris celles avec les références bibliographiques, les tableaux, etc. L'auteur recevra une lettre lui donnant bonne réception de son document.

Lorsqu'un article, après sa révision, sera accepté, on demandera à l'auteur d'envoyer la version finale révisée sur disquette (format 3 1/2") en Word 6.0 x Windows, ainsi qu'une copie sur papier.

#### *Préparation du manuscrit*

Sur la première page du manuscrit on indiquera le titre de l'article en abrégé, le titre et noms des auteurs, des institutions, les adresses complètes (y compris code postal et numéro de téléphone); ainsi que tout autre moyen de contact tel que télécopie, courriel, etc. avec l'auteur principal. Le titre abrégé ne devra pas dépasser 45 caractères, plus les espaces nécessaires, et s'écrira sur la partie supérieure de la page 1 du manuscrit en majuscules. Le titre en entier du manuscrit sera écrit en majuscules et minuscules; il devra être aussi bref que possible, sans dépasser 150 caractères (y compris les espaces nécessaires), et avec l'indication des noms des espèces. Les noms des auteurs, des institutions et les adresses seront en italique et en lettres majuscules et minuscules. On laissera un espace en blanc entre le titre et les

noms des auteurs. Les adresses seront indiquées comme de bas à pied de page pour chacun des auteurs après avoir laissé un espace en blanc après les noms. Chaque note de bas de page sera numérotée. On laissera deux espaces en blanc après les adresses.

#### *Titres*

Les titres de chaque chapitre, par exemple Résumé, Introduction, etc. seront alignés à gauche. Laisser deux espaces en blanc entre les notes de bas de page avec les adresses et le Résumé, et entre le titre Résumé et le texte qui suit. Le résumé ne devra pas dépasser les 200 mots. Il s'agira d'un résumé objectif faisant une brève description des processus utilisés et des résultats obtenus, et non pas une simple présentation du travail réalisé avec une description générale des résultats. Laisser un espace en blanc entre la fin du texte du résumé et les mots clés, qui seront écrits en italique ainsi que le titre Mots clés. Les mots clés seront au maximum six et il ne devra pas y avoir de et ou &. Tous les titres principaux de chapitre (14 regular) et sous-chapitre (12 regular) seront en gras avec un espace en blanc avant et après. Le texte commencera sans retrait. Un titre à l'intérieur d'un sous-chapitre s'écrira en italique, suivi d'un point, avec le texte à continuation.

### Tableaux et figures

Les tableaux et les figures iront à la fin du texte en suivant l'ordre d'apparition dans le texte. Les photographies ne seront pas dévolues aux auteurs.

#### *Tableaux*

Les tableaux, y compris les notes de bas de page, devront avoir un espace en blanc avant et après. Le numéro du tableau et le titre s'écriront sur la partie supérieure en italique (12) avec un point à la fin et un espace en blanc en dessous. Sur chaque colonne, titre d'en-tête ou sous-titre, seulement la première lettre du premier mot sera en majuscule. Les tableaux et leur titre seront alignés à gauche,

ainsi que le texte. Les lignes verticales et horizontales seront utilisées seulement si nécessaire. Ne pas utiliser les "tabs" ou la barre d'espacement pour créer un tableau.

### Figures

Les figures, y compris les titres et les légendes, seront précédés et suivis de deux espaces en blanc. Le numéro de la figure et le titre s'écriront sur la partie supérieure en italique (12) avec un point à la fin. Sous la rubrique figure on trouvera les photographies, les graphiques, les cartes, les diagrammes, etc. Dans le cas des diagrammes, la matrice originale avec les données utilisées pour son élaboration devra être envoyée. On recommande l'utilisation de Word 6.0 ou Excel 5.0 pour la présentation des diagrammes.

### Références

Toute référence présente dans le texte devra apparaître sur la liste des références, et chaque référence 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.

- Exemple dans le cas d'une 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.

- Lorsqu'il s'agit de plus d'un auteur:  
Matos, C.A.P., D.L. Thomas, D. Gianola, R.J. Tempelman & L.D. Young. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and nonlinear models: 1. Estimation of genetic parameters 75, 76-87.
- Dans le cas d'un livre ou d'une publication ad hoc, par exemple un rapport, une thèse, etc.:  
Cockrill, W.R. (Ed.). 1994. *The Husbandry and Health of the Domestic Buffalo*. FAO, Rome, Italy, pp 993.
- S'il s'agit d'un acte d'une réunion:  
Hammond, K. 1996. FAO's programme for the management of farm animal genetic resources. In C. Devendra (Ed.), *Proceedings of IGA/FAO Round Table on the Global Management of Small Ruminant Genetic Resources*, Beijing, May 1996, FAO, Bangkok, Thailand, 4-13.
- Lorsque l'information contenue dans l'article ait été obtenue ou dérive d'un site World Wide Web, il faudra mettre le texte entre guillemets; par exemple "tiré de la FAO. 1996" et indiquer dans les Références la forme standard URL:  
FAO. 1996. *Domestic Animal Diversity Information System*, <http://www.fao.org/dad-is/>, FAO, Rome, Italy.

Pour tout envoi de manuscrits ou correspondance au sujet d'AGRI, vous êtes prié d'utiliser l'adresse suivante:

[agri-bulletin@fao.org](mailto:agri-bulletin@fao.org)

Merci pour votre collaboration

## Reglas y normas editoriales

El objetivo del Boletín de Información sobre Recursos Genéticos Animales (AGRI) es la divulgación de la información sobre una mejor gestión de los recursos genéticos animales de interés para la producción alimentaria y agrícola, siguiendo la Estrategia Mundial para la Gestión de los Recursos Genéticos de los Animales Domésticos. Todos los aspectos referidos a la caracterización, la conservación y el uso de estos recursos serán tomados en consideración, de acuerdo con el Convenio sobre la diversidad biológica.

AGRI publicará información sobre genética, encuestas fenotípicas y económicas y descripciones comparativas, uso, desarrollo y conservación de los recursos genéticos animales, así como sobre el desarrollo de estrategias operacionales y normas que permitan una gestión más eficaz de la relación costo/eficacia. Por ello, AGRI prestará especial atención a las contribuciones referidas a razas y normas capaces de contribuir a la intensificación sostenible de los medios (agroecosistemas) con ingresos medios y bajos en el mundo, que comprenden casi la mayor parte de las tierras dedicadas a la producción ganadera; la producción total de alimentos y agricultura provenientes de la ganadería; y el resto de los recursos genéticos de animales domésticos.

Los puntos de vista expresados en los artículos publicados en AGRI son solamente las opiniones de los autores y, por tanto, no reflejan necesariamente la opinión de las instituciones para las cuales trabajan dichos autores, de la FAO o de los editores.

La oportunidad o no de publicar un artículo en AGRI será juzgada por los editores y revisores.

## Publicación electrónica

Además de su publicación impresa, la versión íntegra de AGRI se encuentra disponible electrónicamente en Internet, en el sitio:

*www.fao.org/dad-is/*

## Tipos de artículos

Serán publicados en AGRI los siguientes tipos de artículos:

### Artículos sobre investigación

Se tomarán en consideración para su publicación en AGRI los estudios sobre la caracterización, conservación y uso de los recursos genéticos de los animales domésticos (AnGR) con una buena descripción del entorno. Se agradecerá el envío de fotografías de calidad que presenten a las razas en cuestión en su ambiente natural de producción.

### Artículos de revisión

Se podrán tomar en consideración ocasionalmente aquellos artículos que presenten una revisión de los agroecosistemas, a nivel nacional, regional o mundial, con el desarrollo de uno o más aspectos referidos a la gestión de los recursos genéticos animales, incluidas las revisiones sobre el estado actual de las distintas áreas de AnGR.

### Artículos específicos

Se solicitarán puntualmente artículos sobre temas específicos para ediciones especiales.

### Otro material para publicación

Incluye la revisión de libros, noticias y notas referidas a reuniones importantes, cursos de formación y principales eventos nacionales, regionales e internacionales, así como conclusiones y recomendaciones relacionadas con los objetivos de estos principales eventos. Se invita a los lectores a enviar este tipo de material a los editores.

## Guía para los autores

### Presentación del manuscrito

Los artículos se presentarán en inglés, francés o español, junto con un resumen en inglés y su traducción en francés o español, y se enviarán al editor de AGRI, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Roma, Italia. El artículo deberá ser enviado en versión WinWord en fichero adjunto por correo electrónico a *agri-bulletin@fao.org*. Las fotografías, color o en blanco y negro, se enviarán siempre por correo normal.

Los manuscritos se presentarán con doble espacio y con el número correspondiente a cada línea en el margen izquierdo. Todas las páginas serán numeradas, incluidas las de las referencias bibliográficas, cuadros, etc. El autor recibirá una notificación sobre la recepción de su documento.

En el caso de aceptación de un artículo después de su revisión, se solicitará al autor una versión final de su artículo revisado en disquete (formato 31/2") en Word 6.0 x Windows, así como una copia impresa del mismo.

#### *Preparación del manuscrito*

En la primera página del manuscrito se indicará el título abreviado del artículo, títulos y nombres de los autores, instituciones, direcciones completas (incluido código postal y número de teléfono); así como otros medios de contacto tales como fax, correo electrónico, etc. del autor principal. El título abreviado no deberá sobrepasar los 45 caracteres más los espacios correspondientes, y aparecerá en la parte superior de la página 1 del manuscrito en mayúsculas. El título entero del manuscrito se escribirá en mayúsculas y minúsculas. Dicho título debe ser lo más breve posible y no sobrepasar los 150 caracteres (incluidos los espacios necesarios), con los nombres de las especies, si necesario. Los nombres de los autores, instituciones y direcciones se escribirán en cursiva y en letras mayúsculas y minúsculas. Se dejará una línea en blanco

entre el título y los nombres de los autores. Las direcciones se escribirán como notas de pie de página de cada autor después de dejar una línea en blanco entre los nombres y éstas. Cada nota de pie de página con la dirección será indicada numéricamente. Se dejarán dos líneas en blanco después de las direcciones.

#### *Títulos*

Los títulos de cada sección, por ejemplo Resumen, Introducción, etc., serán alineados a la izquierda. Dejar dos líneas en blanco entre las notas de pie de página con las direcciones y el Resumen y entre el título Resumen y el texto que sigue. El resumen no deberá exceder de 200 palabras. Deberá ser un resumen objetivo que describa brevemente los procesos y logros obtenidos, y no una presentación de cómo se ha llevado a cabo el estudio y una descripción genérica de los resultados. Dejar una línea en blanco entre el final del texto del resumen y las palabras clave, que se escribirán en cursiva así como el título Palabras clave. No deberán ser más de seis y no deberán contener "y" o "&". Todos los títulos principales de capítulo (14 regular) y subcapítulo (12 regular) serán en negrita e irán precedidos y seguidos de una línea en blanco. El texto correspondiente empezará sin sangrado. Un título dentro de un subcapítulo se escribirá en cursiva e irá seguido de un punto con a continuación el texto correspondiente.

### Cuadros y figuras

Los cuadros y las figuras se incluirán al final del texto siguiendo el orden de cita dentro del mismo. Las fotografías no serán devueltas a sus autores.

#### *Cuadros*

Los cuadros, incluidas las notas de pie de página, deberán ir precedidos y seguidos por dos líneas en blanco. El número del cuadro y su título se escribirán en la parte superior en cursiva (12) con un punto al final y seguido

de una línea en blanco. En cada columna o título de encabezamiento o subtítulo, sólo la primera letra de la primera palabra irá en mayúscula. Los cuadros irán numerados de forma consecutiva con números árabes. Los cuadros y sus títulos se alinearán a la izquierda, así como el texto. Se utilizarán líneas horizontales o verticales sólo cuando sea necesario. No utilizar tabuladores o la barra espaciadora para crear un cuadro.

### *Figuras*

Las figuras, incluidos los títulos y leyendas, irán precedidas y seguidas de dos líneas en blanco. El número de la figura y el título se escribirán en la parte superior en cursiva (12) con un punto al final. La palabra figura incluye las fotografías, los gráficos, los mapas, los diagramas, etc. En el caso del diagrama se enviará la matriz original con los datos utilizados para crearlo. Se recomienda encarecidamente la utilización de Word 6.0 o Excel 5.0 para la presentación de los diagramas.

### **Referencias**

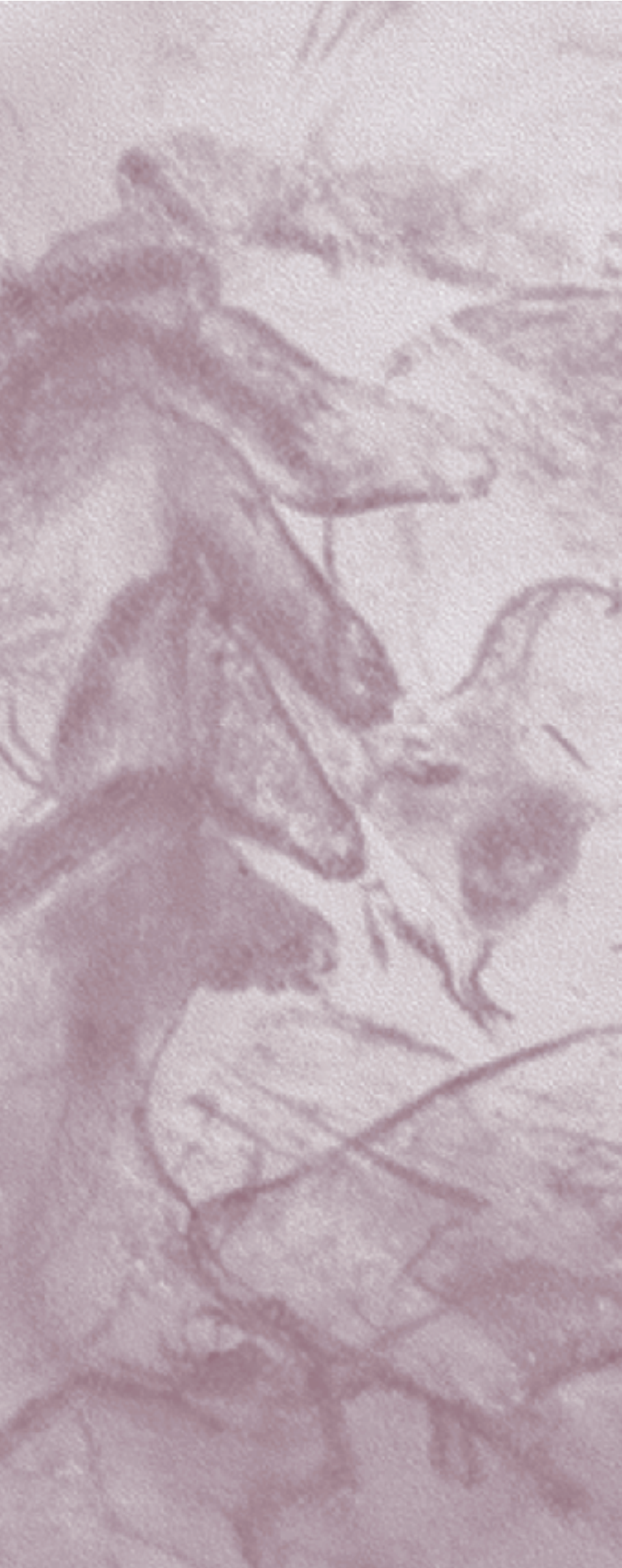
Toda referencia presente en el texto deberá aparecer en la lista de referencias y, de la misma manera, cada referencia de la lista deberá haber sido citada por lo menos una vez en el texto. Las referencias deben ir en orden alfabético del apellido del autor, seguido por el año.

- 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.
- Cuando se trate de más de un autor:  
Matos, C.A.P., D.L. Thomas, D. Gianola, R.J. Tempelman & L.D. Young. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and nonnlinear models: 1. Estimation of genetic parameters 75, 76-87.
- En el caso de un libro o de una publicación ad hoc, por ejemplo informes, tesis, etc.:  
Cockrill, W.R. (Ed.). 1994. *The Husbandry and Health of the Domestic Buffalo*. FAO, Rome, Italy, pp 993.
- Cuando se trate de un artículo dentro de las actas de una reunión:  
Hammond, K. 1996. FAO's programme for the management of farm animal genetic resources. In C. Devendra (Ed.), *Proceedings of IGA/FAO Round Table on the Global Management of Small Ruminant Genetic Resources*, Beijing, May 1996, FAO, Bangkok, Thailand, 4-13.
- Cuando la información contenida en el artículo haya sido obtenida o derive de un sitio World Wide Web, poner el texto entre comillas; por ejemplo "sacado de la FAO. 1996" e indicar en las Referencias la forma estándar URL:  
FAO. 1996. *Domestic Animal Diversity Information System*, <http://www.fao.org/dad-is/>, FAO, Rome, Italy.

Se ruega enviar los manuscritos o la correspondencia relativa a AGRI a la dirección siguiente:

[agri-bulletin@fao.org](mailto:agri-bulletin@fao.org)

Gracias por su colaboración



ISBN 978-92-5-005764-4 ISSN 1014-2339



9 789250 057644

TC/D/A1206Tri/1/07.07/2400