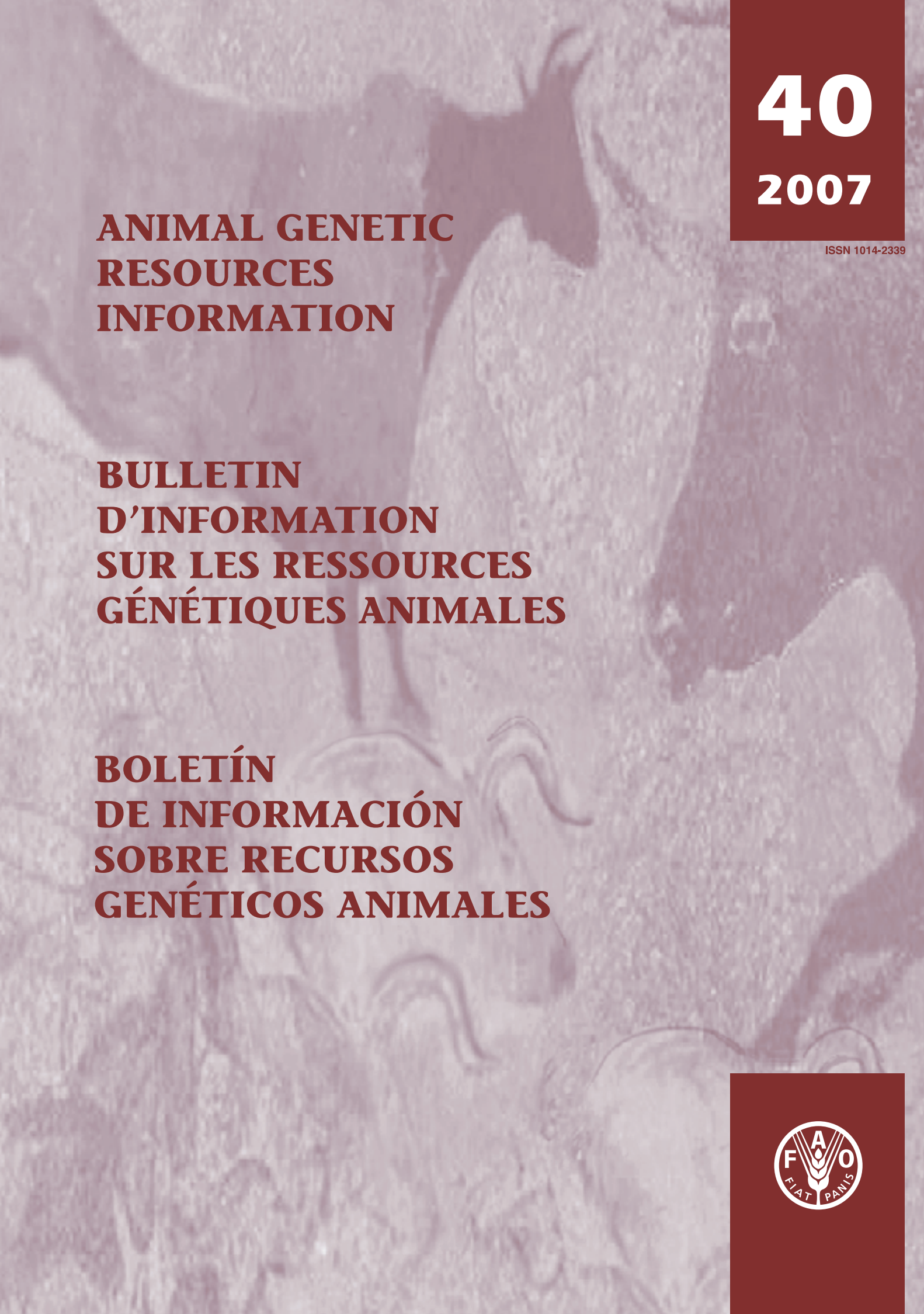

ANIMAL GENETIC RESOURCES INFORMATION

BULLETIN D'INFORMATION SUR LES RESSOURCES GÉNÉTIQUES ANIMALES

BOLETÍN DE INFORMACIÓN SOBRE RECURSOS GENÉTICOS ANIMALES

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Editorial - The Interlaken Conference

In December 2006, the Intergovernmental Working Group on Animal Genetic Resources convened in Rome for its fourth session[1]. The Working Group made a series of recommendations to FAO's Commission on Genetic Resources on Genetic Resources for Food and Agriculture on how best to address opportunities and challenges for animal genetic resources through international policy measures. The finalization of *The State of the World's Animal Genetic Resources for Food and Agriculture,* and the upcoming International Technical Conference on Animal Genetic Resources, to be held in September this year in Interlaken[2], Switzerland, make 2007 an important year for intergovernmental policy-making in the area of animal genetic resources.

The first draft of *The State of the World's Animal Genetic Resources for Food and Agriculture* [3], the first ever global assessment of the status and trends of animal genetic resources, and the capacity of countries to manage them, was presented to the Working Group. The Working Group asked FAO to revise the document on the basis of comments provided by countries. The revised *State of the World's Animal Genetic Resources for Food and Agriculture* is expected to be approved in June by the Commission, for publication and presentation at the Interlaken Conference.

The Working Group recommended that the Interlaken Conference, in addition to the presentation of *The State of the World's Animal Genetic Resources for Food and Agriculture*, negotiates and adopts a Global Plan of Action for Animal Genetic Resources, as its main outcome. This Global Plan of Action will be based on the Strategic Priorities for Action document, which was prepared together with *The State of the World's Animal Genetic Resources for Food and Agriculture* and reflects national, regional and international priorities for action. It addresses four main areas for action: characterization, inventory and monitoring, sustainable use and development, conservation, and policies institutions and capacity building. The Commission on Genetic Resources for Food and Agriculture will convene in June, in Rome, to prepare the various elements of the Global Plan of Action for the Interlaken Conference.

The Interlaken Conference will mark a historic opportunity for the international community to make strategic choices on the future management of animal genetic resources. There is a greater need than ever, for those concerned about the management of animal genetic resources, to work together to formulate well-informed positions on priorities for action, sensible approaches to the conservation and better use of animal genetic resources to enhance food security and sustainable development, securing broad access to animal genetic resources for farmers and breeders, and the fair and equitable sharing of benefits deriving from these resources. The preparation of the Interlaken Conference calls for collaboration at national, regional and international levels, among a broad range of stakeholders, including policy-makers, scientists, non-governmental organizations, breeders and livestock keepers.

On a final note, we are happy to announce that the latest version of the Domestic Animal Diversity Information System - DAD-IS:3 has been launched[4], eleven years after DAD-IS:1 went live. Countries have full responsibility and ownership for their data; DAD-IS: 3 enables countries and regions to set up their own national[5] or regional information systems[6], and exchange data with the global information system. The new system is more user-friendly and provides additional tools for the management of animal genetic resources.

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[1] Documentation at *www.fao.org/ag/againfo/programmes/en/genetics/angrvent2006.html*
[2] See *www.fao.org/ag/againfo/programmes/en/genetics/angrvent2007.html*
[3] See *www.fao.org/ag/againfo/programmes/en/genetics/documents/AH473e00.pdf*
[4] See *ww.fao.org/dad-is/*; contact the DAD-IS moderator at DAD-IS@fao.org
[5] See Poland's Farm Animal Biodiversity Information System at *http://efabis.izoo.krakow.pl/*
[6] See European Farm Animal Biodiversity Information System at *http://efabis.tzv.fal.de/*

Éditorial - La Conference de Interlaken

En décembre 2006 le Groupe de Travail pour les ressources génétiques animales a célébré sa quatrième session à Rome[1]. Le Groupe de Travail à l'occasion a fait une série de recommandations à la Commission pour les Ressources Génétiques pour l'Alimentation et l'Agriculture de la FAO sur comment utiliser au mieux les opportunités et faire face aux défis que représentent les ressources génétiques animales à travers des mesures politiques internationales. La finalisation du rapport sur la *Situation Mondiale des Ressources Génétiques Animales pour l'Alimentation et l'Agriculture*, ainsi que la prochaine Conférence Technique Internationale sur les Ressources Génétiques Animales qui aura lieu au mois de septembre à Interlaken[2], en Suisse, fait de 2007 une année importante pour la politique intergouvernementale dans le domaine des ressources génétiques animales.

Le premier brouillon sur la *Situation Mondiale des Ressources Génétiques Animales pour l'Alimentation et l'Agriculture* [3], le premier contrôle global sur la situation et tendances des ressources génétiques animales, et la capacité de gestion de la part des pays, ont été présentés au Groupe de Travail. Le Groupe de Travail a demandé à la FAO de revoir le document sur la base des commentaires fait par les pays. Le document revu sur la *Situation Mondiale des Ressources Génétiques Animales pour l'Alimentation et l'Agriculture* sera présenté pour approbation par la Commission en juin, pour son ultérieure publication et présentation à la Conférence de Interlaken.

Le Groupe de Travail a recommandé que la Conférence de Interlaken en outre à la présentation de la *Situation Mondiale des Ressources Génétiques Animales pour l'Alimentation et l'Agriculture*, negotie et adopte un Plan d'Action Global pour les Ressources Génétiques Animales comme objectif principal. Ce Plan d'Action Global sera basé sur le document sur les Priorités Stratégiques d'Action qui a été préparé en même temps que le rapport sur la *Situation Mondiale des Ressources Génétiques Animales pour l'Alimentation et l'Agriculture* et reflète les priorités d'action aux niveaux national, régional et international. Le document contient quatre domaines principaux d'action: la caractérisation, l'inventaire et le suivi, l'utilisation durable et le développement, la conservation, et les politiques institutionnelles et capacité d'action. La Commission pour les Ressources Génétiques pour l'Alimentation et l'Agriculture se réunira en juin à Rome pour préparer les différents éléments nécessaires au Plan d'Action Global pour la Conférence de Interlaken.

La Conférence de Interlaken représentera une opportunité historique pour la communauté internationale qui pourra réaliser des choix stratégiques pour le futur de la gestion des ressources génétiques animales. Il y a aujourd'hui un besoin croissant pour ceux qui se préoccupent de la gestion des ressources génétiques animales de travailler ensemble pour formuler des positions bien documentées sur les priorités d'action, établir des approches adéquates pour la conservation et meilleure utilisation des ressources génétiques animales pour améliorer la sécurité alimentaire et le développement durable, assurer un plus ample accès aux ressources génétiques animales de la part des éleveurs et améliorateurs, et une meilleure et plus équitable distribution des bénéfices dérivés de ces ressources. La préparation de la Conférence de

[1] Documentation sur *www.fao.org/ag/againfo/programmes/en/genetics/angrvent2006.html*
[2] Voir *www.fao.org/ag/againfo/programmes/en/genetics/angrvent2007.html*
[3] Voir *www.fao.org/ag/againfo/programmes/en/genetics/documents/AH473e00.pdf*

Interlaken nécessite de la collaboration aux niveaux national, régional et international des propriétaires, y compris les législateurs, chercheurs, organisations non gouvernementales, améliorateurs et éleveurs.

Finalement, nous sommes heureux d'annoncer que la dernière version du Système d'Information sur la Diversité des Animaux Domestiques – DAD-IS 3 a été lancée[4] onze ans après la création du DAD-IS 1. Les pays sont pleinement responsables et propriétaires de leurs données; DAD-IS 3 permettra aux pays et régions de développer leur propres systèmes d'information national[5] ou régional[6], ainsi que d'échanger des données avec le système global d'information. Le nouveau système a été conçu pour une utilisation plus facile et proportionne des outils complémentaires pour la gestion des ressources génétiques animales.

[4] Voir *ww.fao.org/dad-is/*; contact the DAD-IS moderator at DAD-IS@fao.org
[5] Voir Poland's Farm Animal Biodiversity Information System at *http://efabis.izoo.krakow.pl/*
[6] Voir European Farm Animal Biodiversity Information System at *http://efabis.tzv.fal.de/*

Editorial - La Conferencia de Interlaken

En diciembre del 2006 se reunió en Roma en su cuarta sesión el Grupo de Trabajo Intergubernamental para los Recursos Zoogenéticos. El Grupo de Trabajo hizo una serie de recomendaciones a la Comisión para los Recursos Genéticos para la Alimentación y la Agricultura de la FAO sobre como aprovechar mejor las oportunidades y enfrentarse a los desafíos planteados por los recursos zoogenéticos a través de una serie de medidas políticas internacionales. La finalización del informe sobre la *Situación Mundial de los Recursos Zoogenéticos para la Alimentación y la Agricultura*, así como la próxima Conferencia Técnica Internacional sobre recursos zoogenéticos que tendrá lugar en septiembre en Interlaken, en Suiza, hace del 2007 un año importante en cuanto al establecimiento de políticas intergubernamentales en el campo de los recursos zoogenéticos.

El primer borrador de la *Situación Mundial de los Recursos Zoogenéticos para la Alimentación y la Agricultura*, el primer control sobre la situación y tendencias de los recursos zoogenéticos, así como la capacidad de los paises de gestionarlos, fue presentado al Grupo de Trabajo. El Grupo de Trabajo pidió a la FAO revisar el documento en base a los comentarios proporcionados por los paises. La versión revisada de la *Situación Mundial de los Recursos Zoogenéticos para la Alimentación y la Agricultura* se espera sea aprobada en junio por la Comisión para su posterior publicación y presentación a la Conferencia de Interlaken.

El Grupo de Trabajo recomendó que la Conferencia de Interlaken, además de la presentación de la *Situación Mundial de los Recursos Zoogenéticos para la Alimentación y la Agricultura*, negociara y adoptara un Plan de Acción Global para los Recursos Zoogenéticos como punto principal del programa. Este Plan Global de Acción se basara sobre el documento sobre las Prioridades Estratégicas de Acción que fue preparado junto con la *Situación Mundial de los Recursos Zoogenéticos para la Alimentación y la Agricultura* y que refleja las prioridades de acción a nivel nacional, regional e internacional. El documento se centra en cuatro temas principales de acción: la caracterización, el inventario y seguimiento, la utilización sostenible y el desarrollo, la conservación, y las políticas institucionales y capacidad de acción. La Comisión sobre Recursos Genéticos para la Alimentación y la Agricultura se reunirá en junio en Roma para preparar los distintos elementos necesarios para la elaboración del Plan Global de Acción para la Conferencia de Interlaken.

La Conferencia de Interlaken representa una oportunidad histórica para la comunidad internacional de realizar elecciones estratégicas sobre la gestión futura de los recursos zoogenéticos. Hoy en día es incluso mayor la necesidad para aquéllos preocupados por la gestión de los recursos zoogenéticos trabajar juntos para formular posiciones comunes bien documentadas sobre las prioridades de acción, enfocar mejor la conservación y mejorar el uso de los recursos zoogenéticos para favorecer la seguridad alimentaria y el desarrollo sostenible, asegurar un acceso mayor a los recursos zoogenéticos a los ganaderos y mejoradores, y garantizar un mejor y mas equilibrado reparto de los beneficios provenientes de estos recursos. La preparación de la Conferencia de Interlaken necesita de la

[1] Documentación en *www.fao.org/ag/againfo/programmes/en/genetics/angrvent2006.html*
[2] Ver *www.fao.org/ag/againfo/programmes/en/genetics/angrvent2007.html*
[3] Ver *www.fao.org/ag/againfo/programmes/en/genetics/documents/AH473e00.pdf*

colaboración a nivel nacional, regional e internacional, de un amplio panel de propietarios, incluidos los legisladores, científicos, organizaciones non gubernamentales, mejoradores y ganaderos.

Por fin, nos alegra anunciar que la ultima versión del Sistema de Información sobre la Diversidad de los Animales Domésticos – DAD-IS 3 ha sido lanzada[4] tras once años después de la creación del DAD-IS 1. Los paises son plenamente responsables y propietarios de sus propios datos; DAD-IS 3 permite a los paises y regiones instalar su propio sistema nacional[5] o regional[6] e intercambiar datos con el sistema de información global. El nuevo sistema ha sido diseñado para facilitar su utilización y proporciona herramientas adicionales para la gestión de los recursos zoogenéticos.

[4] Ver *ww.fao.org/dad-is/;* contact the DAD-IS moderator at DAD-IS@fao.org
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The use of reproductive and molecular biotechnology in Animal Genetic Resources management – a global overview[1]

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Summary

As part of the country-driven strategy for the management of animal genetic resources, FAO invited 188 countries to participate in the preparation of the First Report on the State of the World's Animal Genetic Resources. Utilizing the information provided in the 148 country reports ready for analysis in July 2005, this paper presents a global overview of the state of capacity and utilization of reproductive and molecular biotechnologies in the management of animal genetic resources. Regional descriptions outline the distribution of different biotechnologies, along with a discussion of the species and breed focus of their use, and stakeholder involvement in service delivery. Unsurprisingly, there is a big gap in biotechnology use between developed and developing countries, with artificial insemination being the technology most widely applied in developing countries. More complex technologies such as embryo transfer and molecular tools, are even less common in developing countries. Use of biotechnologies is in general biased towards cattle, and examples of the application of biotechnologies in the management of locally adapted breeds are limited. Most developing countries express the wish to increase the utilization of biotechnologies. However, in many cases clear plans for incorporating technologies into animal genetic resource management are lacking.

Resumen

Como parte de la estrategia de liderazgo de los países en la gestión de los recursos zoogenéticos, la FAO invitó 188 países a participar en la preparación del Primer Informe sobre la situación mundial de los recursos zoogenéticos. Utilizando la información proporcionada por los 148 informes nacionales listos para analizar en julio del 2005, este artículo presenta una visión global de la capacidad y utilización des las biotecnologías reproductivas y moleculares en la gestión de los recursos zoogenéticos. Las descripciones regionales evidencian la distribución de las distintas biotecnologías junto con una discusión sobre especies y razas focalizada sobre su uso, así como la implicación de los ganaderos en la entrega de servicios. Se comprueba sin sorpresa que existe una gran diferencia en la utilización de la biotecnología entre países desarrollados y en desarrollo. Tecnologías más complejas, tales como la transferencia de embriones y herramientas moleculares son incluso menos comunes en los países en desarrollo. La utilización de biotecnologías está orientada hacia los bovinos y los ejemplos de aplicación de biotecnologías en la gestión de razas locales adaptadas es muy limitado. Muchos de los países en desarrollo solicitan un aumento en la utilización de las biotecnologías. Sin embargo, en muchos casos existe una escasez de planes efectivos para la incorporación de nuevas tecnologías en la gestión de los recursos zoogenéticos.

Keywords: *Biotechnology, Animal genetic resources, Artificial insemination, Embryo transfer, Molecular genetics.*

Introduction

The development of biotechnologies in the fields of breeding, reproduction and molecular genetics has advanced markedly in recent years. Reproductive biotechnologies for livestock have the potential to increase reproductive efficiency and rates of animal genetic improvement. Advances in artificial insemination (AI) and multiple ovulation followed by embryo transfer (MOET) have already had a major impact on livestock improvement programmes in developed countries. AI and MOET

[1]This paper updates and completes the preliminary analysis published in an earlier paper by Cardellino *et al.*, 2005.

speed up genetic progress, reduce the risk of disease transmission and expand the number of animals that can be bred from a superior parent. Technologies such as genomics and molecular markers are valuable in understanding, characterizing and managing animal genetic resources (FAO, 2004).

Recent years have also seen an increased recognition that farm animal genetic diversity is an important resource, which enables the livestock sector to meet diverse requirements and to adapt to emerging needs and challenges. Similarly, it is recognized that this diversity is eroding at a worrying speed. The urgent need to address the issue is heightened by rapid changes to the livestock sector associated with the increasing demand for livestock products, which is occurring in many developing countries (Delgado *et al.*, 1999). At the same time, the Millennium Development Goals have focussed attention on poverty alleviation, and the immediate concerns in the developing world are for food security and economic development. While reproductive biotechnologies, have the potential to enhance livestock productivity, there is also a concern that inappropriate or unplanned use, in particular of AI, can lead to increased rates of genetic erosion and breed extinction.

The Food and Agriculture Organization of the United Nations (FAO) has been asked by its member countries to develop and implement a country-driven Global Strategy for the Management of Farm Animal Genetic Resources. One part of the process is to understand and analyse the national and global state of animal genetic resources. FAO invited 188 countries to submit country reports (CRs), which are currently being analysed to obtain a global picture and to produce the First Report on the State of the World's Animal Genetic Resources.

The objective of this paper is to distil and analyse the information provided in the CRs regarding the use of biotechnologies in livestock breeding and reproduction, as well as for research into livestock genetics. Examples, illustrating the application of biotechnologies, in particular in the management of locally adapted breeds of livestock, are drawn from the CRs. It should be noted that applications of biotechnology, not related to reproduction and breeding, are not considered. Moreover, a detailed assessment of the use of biotechnologies for the purposes of cryoconservation is not included. The paper also outlines the views expressed in the CRs regarding constraints, opportunities and priorities related to the development and utilization of biotechnologies for the management of farm animal genetic resources.

Methods

The findings presented in this paper are based on the 148 CRs that were available by July 2005 (the completion date for each CR is shown in Appendix 1). The countries had been offered guidelines for the preparation of the reports, one section of which was to be devoted to reviewing the state of national capacities, and assessing future capacity building requirements (FAO, 2001). The CRs, thus, offered a useful resource on which to base an assessment of the current global state of capacity and utilization of biotechnologies across a wide range of production systems, and in the context of ongoing changes to the livestock sector.

Reports were classified on the basis of the regional classification established by FAO for the purposes of preparing the First Report on the State of the World's Animal Genetic Resources (a total of seven regions). The study considered 42 reports from Africa, 25 from Asia, 39 from Europe, 22 from Latin America and the Caribbean, 7 from the Near and Middle East, 2 from North America and 11 from the Southwest Pacific. The distribution of the countries covered in this paper, by region is shown in Appendix 1.

The numbers of countries within each region reporting a particular activity is presented. Data relating to the species and type of breeds to which the biotechnologies are applied, and the types of institutions involved in the provision and utilization of the biotechnologies, are analysed where available. As the data was not obtained on the basis of formal sampling or a standard questionnaire, no statistical analysis was carried out, and the results are presented descriptively. As it was not always clear from the CRs whether a particular technology was being used or not, the number of reports providing the relevant information is presented for each set of results. The names of individual countries are not mentioned in the presentation of the quantitative information. However, where illustrative examples are offered, the relevant CR(s) are cited. Also, where a small number of countries depart markedly from the general pattern of the region, this is indicated.

Table 1. Reported use of biotechnologies by region.

Region	No. of CRs	Artificial insemination		Embryo transfer		Molecular genetic technologies	
		No. providing info.	Reporting use of the technology	No. providing info.	Reporting use of the technology	No. providing info.	Reporting use of the technology
Africa	42	42	74%	30	17%	29	14%
Asia	25	22	86%	17	47%	16	50%
Europe	39	39	97%	25	64%	29	83%
Latin America and the Caribbean	22	22	95%	14	86%	15	73%
Near and Middle East	7	6	100%	3	33%	5	40%
North America	2	2	100%	2	100%	2	100%
Southwest Pacific	11	11	55%	10	10%	9	11%

Table 2. Reported use of biotechnologies by species.

	Artificial insemination			Embryo transfer			Molecular genetic technologies		
		Reporting use of the technology:			Reporting use of the technology:			Reporting use of the technology:	
Region	No. with info on species	In cattle	In other species	No. with info on species	In cattle	In other species	No. with info on species	In cattle	In other species
Africa	31	100%	10%	4	100%	0%	3	100%	33%
Asia	18	94%	56%	6	100%	50%	7	86%	100%
Europe	38	100%	66%	11	100%	36%	18	89%	100%
Latin America and the Caribbean	21	100%	71%	12	100%	33%	9	78%	89%
Near and Middle East	6	100%	33%	1	0%	100%	2	0%	100%
North America	2	100%	50%	0	-	-	1	100%	100%
Southwest Pacific	5	100%	80%	2	100%	0%	0	-	-

Results

Table 1 presents a region-by-region overview of the proportion of countries reporting the use of different classes of biotechnology. It can be seen that AI is by far the most widely used biotechnology, but particularly in the Africa and Southwest Pacific regions, there are many countries where it is unavailable. In the case of ET and molecular techniques the gap between the developed and developing regions is even greater. Table 2 gives an indication of the bias in favour of cattle in the application of biotechnologies. The table shows a greater bias with respect to ET, but it can also be seen that in most regions the use of AI is also dominated by the cattle sector. In the Africa region in particular, few countries have extended the use of AI to other species. The evidence for such a species bias is rather less in the case of molecular genetic technologies. The number of countries reporting the use of such technologies is quite low. However, among these a relatively high number report studies of molecular characteristics in at least one species other than cattle. Nonetheless, cattle remain the single dominant species in most regions; particularly so where commercial applications of the technologies are concerned. Further details of the distribution of biotechnology use and of the species to which they are applied are included in the following regional descriptions.

Africa

The CRs indicate that AI is the biotechnology most commonly used in the management of animal genetic resources in Africa. The CRs generally express an aspiration for greater use of the technology in the management of genetic resources, notably in facilitating breeding programmes and the introduction of exotic germplasm. This aspiration corresponds to the overall objective expressed in most African CRs, of promoting food security through increased livestock productivity. In many cases, the desire for more widespread use of AI is tempered by concern regarding the implications of its inappropriate or uncontrolled use for genetic diversity and the availability of livestock well adapted to the local production conditions. A number of CRs also mention the potential use of AI facilities for purposes of cryoconservation.

Thirty-one out of 42 countries report the use of AI. A few other countries report that AI has been carried out experimentally in the past, but never applied routinely, or that former AI programmes have been abandoned through lack of financial resources or other constraints. AI use in Africa is predominantly concerned with cattle. All 31 CRs reporting the use of AI mentioned that the technology is used in cattle. Two countries report the use of AI in sheep, 1 in goats, 1 in horses and 1 in pigs. The semen used for AI tends to be from exotic breeds rather than local breeds. Nineteen countries indicate that AI was performed using semen from exotic cattle breeds, 2 report using semen from local breeds and 6 report use of both local and exotic semen. Where details of programmes are provided, the objective is often the upgrading of indigenous livestock using semen from exotic breeds, most frequently of dairy cattle. Exotic beef cattle semen is also utilized in a number of countries.

Some CRs from West Africa mention the use of exotic semen for cross-breeding with trypanotolerant cattle breeds (Guinea CR; Côte d'Ivoire CR). A limited number of AI programmes utilizing semen from indigenous animals are reported, including in one country the use of semen from trypanotolerant cattle (Côte d'Ivoire CR). The Madagascar CR notes the use of AI in *in situ* conservation programmes for the endangered Renitilo cattle breed. However, even in countries where indigenous breeds are included in AI programmes, the balance appears to favour exotics. One report indicates that 94.1 percent of AI services were carried out using the semen of exotic breeds (Botswana CR). One report notes considerable use of AI to introduce exotic germplasm into the breeding of race horses (Senegal CR). The use of AI by smallholders is largely restricted to dairy producers and is concentrated in peri-urban areas. A small number of CRs mention efforts to promote a wider diffusion of the technology, including less easily accessible areas.

There is considerable variation from country to country in terms of the development of facilities and human resources for the implementation of AI programmes, in terms of the availability of services to the farmer, and in terms of the providers involved in service delivery. The public sector is the most frequently reported provider of AI services. Among the 27 reports providing information on service providers, 26 mention the public sector and 12 mention private companies. NGOs are mentioned as providers of AI services by 8 CRs, while breeders' organizations are mentioned in 2 reports (Burkina Faso and Madagascar). The CR from Niger mentions collaboration between two Italian universities, a local university and a local research station in establishing an AI programme

for cattle. The CR from Zambia indicates that individual private farmers have imported exotic semen for the purposes of improving their cattle herds.

Several countries report that problems with the financing of government services are a constraint to the provision of AI. Increased involvement by the private sector is noted as an objective in several CRs. A few countries are able to report significant progress in this direction (for example, Kenya CR, Zambia CR). The CR from Zambia notes that the private sector has taken the lead in providing imported semen, while the government trains and supervises A.I. technicians. However, as the above figures indicate the role of the private sector appears to be limited or absent in most countries. Few CRs discuss constraints to the involvement of the private sector in any detail. However, the CR from Côte d'Ivoire reports that the single private operator in the country had ceased activities as a result of financial difficulties.

Five countries (Côte d'Ivoire, Kenya, Madagascar, Zambia, and Zimbabwe) report the use of embryo transfer (ET) technologies. Use of the technology appears to be limited. In one country, the technology is reported only to have been used on Holstein-Friesian cattle on a single private farm (Madagascar CR). The CR from Côte d'Ivoire notes that some individual cattle owners have introduced Brazilian Zebu genetic material through the import of frozen embryos. In Zimbabwe, the technology is available through two private breeding companies (Zimbabwe CR). Several CRs state that the introduction of ET is an objective. However, the specific role that the technology could be expected to play in the management of genetic resources in the local production systems is rarely elucidated. There is a lack of discussion of how it could be integrated within organized breeding programmes. The potential use of the technology for purposes of cryoconservation is, however, noted in several CRs. Very few countries report the use of other biotechnologies. Molecular genetic evaluation and distancing studies in cattle are each mentioned in two CRs.

Asia

Among the Asian CRs 19 out of 22 countries providing information indicate the use of AI. From 18 countries providing details of the species inseminated, 17 mention cattle, 8 pigs, 5 buffaloes, 4 sheep, 3 chickens, 2 goats, 2 horses, and 1 camels and 1 ducks. Details of the breeds used as the source of semen are limited. However, in the case of cattle 8 CRs indicate the use of semen from both local and exotic breeds, 4 mention only exotic breeds, and 2 mention only local breeds. Provision of AI services appears to be dominated by the public sector. Of 17 reports giving details of service providers, all 17 mention the public sector, with 6 mentioning the private sector, 5 breeders' organizations 4 NGOs and 1 universities. There is much variation from country to country in the extent to which AI is used. In an industrialized country such as Japan, almost all cattle breeding (99.4 percent in dairy herds and 97.8 percent in beef herds) is carried out using AI (Japan CR). In most other Asian countries, services are much more limited and tend to be focused on the dairy sector and peri-urban production systems. Several reports indicate that service coverage is limited by financial and technical constraints. Indeed, a few reports indicate a decline in the use of the technology.

The desire to establish or to increase the availability of AI services is expressed as an objective in many reports. In a number of countries AI has served as a means of introducing exotic germplasm for the purposes of cross-breeding with local breeds. The technology has been used in the development of synthetic breeds incorporating both exotic and indigenous genes, an example being the Jermasia goat (Malaysia CR). In some cases, AI has also been used to upgrade cross-breeds back to indigenous breeds through back-crossing to promote hardiness. This approach has been applied, for example, using Kedah-Kelantan semen in cattle herds introduced to tree plantations (Malaysia CR). In some cases, AI services supply semen from indigenous breeds, for example Sahiwal cattle (Pakistan CR). However, the same CR indicates that the collection of semen from some other indigenous cattle breeds was discontinued because of a lack of demand.

Eight out of 17 Asian countries providing information on the matter indicate some use of ET technology. Among the 6 countries providing details of the species in which the technology is implemented, 6 mention cattle, 2 buffaloes, 1 horses and 1 goats. The breeds involved are rarely detailed, but one report mentions the transfer of embryos from indigenous cattle breeds and one mentions exotic breeds. In most countries ET is used on a very limited scale and is often largely confined to research. One CR indicates that although capacity to use the technology was previously developed it has now been abandoned. ET technology was used in the development of the Mafriwal cattle breed (Malaysia CR). The potential role of the technology

in cryoconservation programmes is noted in several CRs.

Eight out of 16 Asian countries providing information on the matter report the use of molecular genetic technologies. Among these countries, 6 specify genetic distancing studies, and 2 mention marker assisted selection. Among the 7 countries providing details of the species involved in molecular evaluation studies, 6 mention cattle, 5 chickens, 4 sheep, 4 goats, 4 pigs, 3 buffaloes, 2 ducks, 2 horses, 1 camels, 1 deer, 1 quail and 1 guinea fowl. In the case of distancing studies, among the 5 countries providing details of the species involved, 4 mention chickens, 3 cattle, 3 sheep, 3 goats, 2 pigs, 2 buffaloes, 2 horses, 1 ducks, and 1 deer. With regard to the breeds involved in molecular genetic studies, systemized studies on Asian breeds are being conducted by the Society for Research on Native Livestock in Japan, including analysis based of genetic relationships based on mitochondrial DNA polymorphisms and other DNA markers (Japan CR). Native Japanese breeds covered by the studies include Mishima cattle and Kuchinoshima feral cattle (ibid.).

Other biotechnologies are very largely restricted to the most industrialized countries in the region. The use of *in vitro* fertilization is mentioned in two CRs. The Japan CR indicates that a number of other reproductive biotechnologies with potential for use in the propagation of rare breeds, as well as commercial applications, have been utilized at an experimental level. The technologies include sperm microinjection to fertilize eggs – applied in pigs; primordial germ cell (PGC) and chimera germline techniques – applied in chickens; and cloning technologies used in cattle, pigs and goats (ibid.).

Europe

Thirty eight of 39 European countries report the use of AI. All 38 mention the use of the technology in cattle, 23 in pigs, 16 in sheep, 9 in horses, 8 in goats, 2 in rabbits, and in 1 chickens. Most countries which give details report using semen from both local and imported breeds of cattle, pigs and sheep. While most countries are able to report the existence of some AI provision, there is great variation between countries in the extent to which the technology is utilized. In many countries, particularly in western Europe, AI is widely available and used throughout the livestock sector, most notably in dairy cattle. However, a number of CRs from eastern Europe and the Caucasus, where the livestock sector has often faced considerable problems and declining populations, indicate that capacity to provide AI services is severely limited as a result of the disintegration of formerly existing infrastructure.

A range of providers are involved in the delivery of AI services. Of the 32 countries giving details of providers, 24 mention the private sector, 20 the public sector, 19 breeders' organizations and 3 universities. In eastern Europe and the Caucasus, services where they are available, are more likely to be provided by the public sector. Conversely, elsewhere in the region, the private sector and farmers' organizations are the most frequently mentioned service providers, although in many countries there is still considerable involvement or support from the public sector. Transfer of services to the private sector has not always been without problems; the CR from Romania reports that reogranization and greater independence of AI institutes, along with the introduction of service charges, led to a decline in uptake.

In some countries, AI using imported semen has been widely used to increase the productivity of local breeds. However, some concerns are raised in the CRs. Attempts to upgrade local livestock using exotic semen have sometimes failed because the resulting cross-bred animals have proved to be poorly adapted to the local conditions. There is also a potential threat to genetic resource diversity. According to the CR from Greece, inappropriate and unplanned use of AI contributed markedly to the loss of some indigenous breeds.

Sixteen of the 25 countries providing information on the matter report the use of ET. Of the 11 countries providing details of the species involved, all 11 mention cattle, 3 sheep, 2 goats, 1 pigs, 1 horses and 1 rabbits. Where specified, ET is carried out using embryos from both imported and local breeds of cattle. Again, it is the dairy industry which is the main user of the ET. The technology has contributed significantly to increasing the rate at which increased productivity has been achieved through selective breeding. However, as a result of the costs involved in the utilization of the technology it is less widely used than AI, and in some countries ET programmes have ceased as a result of the high costs. In the case of ET, out of 8 countries providing details of service providers, 4 mention the private sector, 4 the public sector, 4 breeders' organizations and 3 universities. Other reproductive technologies such as embryo sexing, cloning and transgenetics are mentioned in a very few CRs as subjects for research.

Twenty-four out of 29 CRs providing information on the matter indicate the use of molecular genetic technologies. Marker assisted

selection, for example, is used in commercial animal production in a number of European countries. The technology can be applied to eliminate a number of undesirable traits related to health or fertility from livestock populations and to assist selective breeding for greater productivity. The importance of ensuring that information on such new technologies, including their economic benefits, are made available to farmers and breeders' organizations is noted in one report (Hungary CR). Another report highlights the prospect that molecular biological methods will facilitate the discovery of genes for economically important traits in locally adapted breeds, thereby enhancing their value in breeding programmes (Germany CR). However, the same report raises the concern that the use of molecular technologies in the context of market-driven attempts to increase productivity could exacerbate a trend towards inbreeding and loss of genetic diversity within livestock populations. Similar apprehensions are expressed in a small number of other reports. Genetic distancing studies are considered important from the point of view of planning and prioritizing conservation efforts. One CR, however, notes that progress to this end has been limited as interest in the subject is largely restricted to universities, and funding is limited (Belgium CR). Another report puts forward a potential commercial role for such techniques in relation to the development of niche products and the marketing of livestock breeds on the grounds of their close association with a particular geographical location (France CR).

Among the CRs providing details of the use of molecular technologies, 11 specify the implementation of molecular genetic distancing studies and 7 mention the use of marker assisted selection. Out of 17 countries providing information on the species involved in molecular characterization studies, 14 mention cattle, 13 sheep, 11 pigs, 8 horses, 5 goats, 3 chickens, 1 donkeys, 1 turkeys and 1 geese. Out of 12 countries providing information on the species involved in distancing studies, 11 mention sheep, 9 cattle, 5 horses, 4 pigs, 3 chickens, 3 goats, 2 geese, 1duck, 1 donkeys, 1 rabbits, and 1 deer. Out of 4 countries providing information on the species on which marker assisted selection is practised, 4 mention cattle, 4 pigs, 1 chickens and 1 horses. Details of the specific breeds to which technologies have been applied are quite limited in the CRs. Among the local breeds for which molecular characterization or distancing studies are mentioned in the CRs are the Turoplje and Black Slavonian pigs, Ruda sheep, sheep of the islands of Rab, Pag and KrK (Croatia CR); Wallachian and Sumava sheep, Brown goats and White goats (Czech Republic CR) and the Karakachanska sheep (Former Yugoslav Republic of Macedonia CR).

Latin America and the Caribbean

AI is widely practised in the countries of this region. Twenty-one out of 22 countries indicate the use of the technology. All 21 countries report the use of AI in cattle, 13 mention pigs, 8 sheep, 8 goats, 5 horses, 1 rabbits, 1 buffaloes, 1 donkeys 1 llamas, 1 alpacas and 1 turkeys. With regard to the cattle breeds providing the semen used for AI, 13 reports mention only exotic breeds, while 4 mention both local and exotic. In the cases of sheep, 5 reports mention exotic breeds and 1 mentions both exotic and local; and in the case of pigs, 9 CRs mention only exotic breeds while one mentions both local and exotic. It is clear that the predominant objective is to increase the genetic merit of livestock populations using semen from exotic breeds. In many countries, semen is imported from overseas. Use of the technology is most common in the dairy sector. In some countries it is also quite widely used by commercial producers of beef cattle, pigs and small ruminants. However, there is marked variation between countries and between production systems in terms of the extent to which AI is used. In many small-scale or low external input systems, use of the technology is very limited. A number of countries indicate that improving the provision of AI services is an important objective. A small number of reports, however, mention concerns regarding the decrease of genetic diversity arising as a result of the inappropriate use of AI. With regard to the providers involved in the delivery of AI services, the private sector plays an important role in this region. Of 17 reports giving details of service providers, 11 mention the public sector, 9 mention the private sector, and 5 breeders' organizations.

ET technology is increasingly being used by commercial livestock producers in several countries of the region. Twelve reports, out of 14 providing information, report the use of ET. All 12 mention the use of the technology in cattle, 3 in horses, 2 in goats, 2 in sheep, 1 in llamas, 1 in alpacas and 1 in donkeys. Transplanted embryos largely come from exotic breeds – the six countries that provided details of the cattle breeds involved indicate the use of embryos only from exotic breeds. As in the case of AI, though on a more limited scale, use of ET technology is dominated by the dairy industry, with restricted use in other types of commercial livestock production. Some CRs indicate the importation of embryos from overseas. Information on the

providers of ET services is limited. However, two CRs (Brazil and Chile) mention private sector organizations involved in the provision of the technology. Additionally, two CRs indicate some commercial use of *in vitro* fertilization, while one mentions the development of embryo sexing and cloning technologies.

Eleven countries, out of 15 providing information, indicate some use of molecular genetic technologies. With regard to molecular characterization studies, out of 9 countries providing information on the species involved, 7 mention cattle, 3 sheep, 3 pigs, 2 chickens, 2 horses, 1 goats, 1 buffaloes, 1 llamas, 1 alpacas, 1 vicuñas, 1 guanacos and 2 unspecified camelids. Several countries indicate that locally adapted breeds have been included in such studies. The CR from Peru mentions molecular investigations of the genetic distances between South American camelid species. Few reports, however, indicate that molecular technologies have been incorporated in breeding programmes. The Colombia CR notes the potential significance of marker assisted selection programmes utilizing the genes of the Blanco Orejinegro cattle breed, which is reported to show resistance to brucellosis, and which has been the object of molecular characterization studies.

Near and Middle East

In this region all six countries providing information on the matter report the use of AI. With regard to the species involved, all 6 mention cattle, 1 camels and 1 rabbits. One CR mentions the use of ET in camels (Oman CR). The semen used in AI programmes is largely obtained from exotic breeds, either from local populations or imported. A number of CRs note that the use of AI has had an adverse effect on genetic diversity and contributed to the decline of local livestock breeds. One CR indicates some use of semen from a local cattle breed (Syrian Arab Republic CR). Some CRs indicate that the development of AI programmes for local breeds of sheep, goats and/or buffaloes is a priority. The CR from the Syrian Arab Republic, for example, notes that the local Awassi sheep and Shami goats are much sought after in neighbouring countries for breeding, and that plans are in hand to develop AI and ET programmes to meet the demand. Among 6 countries giving information on service providers, 5 mention the public sector, 4 the private sector and 2 breeders' organizations. Some reports, however, indicate constraints to the provision of AI, such as a lack of trained personnel. Several reports note the potential use of AI and ET technologies in cryoconservation. The use of other biotechnologies is limited. One report (Jordan CR) indicates molecular characterization and genetic distancing studies in indigenous goats, while another (Egypt CR) notes that molecular genetic studies of buffalo, sheep and goats have recently been initiated with the aid of regional and international organizations.

North America

In the United States of America and Canada reproductive biotechnologies are readily available. AI is widespread in the dairy and pig industries, and is used to a lesser extent in other sectors such as beef cattle and small ruminants. Concern is expressed at the role of AI in contributing to a reduction in the effective population size of some dairy cattle breeds. Details of the utilization of other biotechnologies are limited in the CRs from this region. In the United States, molecular characterization studies have been carried out, by the industry and public sector institutions, for the most widely kept breeds of dairy cattle and pigs, and also in a number of beef cattle breeds (United States CR). Molecular markers are particularly used for the identification of recessive defects in bulls used for AI. Molecular studies, providing measures of within and between breed genetic diversity, are also used by the National Animal Germplasm Program (NAGP) in the planning of conservation programmes for livestock genetic resources (ibid.).

Southwest Pacific

Biotechnologies are not widely used in this region. Six of the 11 CRs indicate the use of AI. Out of 5 countries indicating the species involved in AI programmes, 5 mention cattle, 4 pigs, 1 sheep and 1 goats. With regard to AI service providers, 2 reports mention the public sector, 2 the private sector and 1 mentions an individual volunteer from a developed country. Several reports from small island countries note the potential of AI as a means of introducing exotic germplasm, but the use of the technology appears to be limited. In some countries a small number of private livestock producers are involved in the import of semen for the purposes of AI in their herds. Two countries (Australia and Vanuatu) indicate the use of ET technology, both reports referring to cattle. Additionally, the CR from Samoa notes the use of the technology for the introduction of the Piedmontese breed during the 1980s. Capacity for the use of biotechnologies is

well developed in Australia, which is the only country from the region reporting the use of molecular genetic techniques to underpin characterization and selection efforts (Australia CR).

Discussion

The information provided by the CRs unsurprisingly indicates that there is a large gap between developed and developing countries in terms of their capacity to make use of biotechnologies in the management and development of livestock genetic resources. Some livestock production systems in a number of South American countries are, however, relatively well able to access biotechnologies as compared to other developing-country systems.

In the developing countries, AI is the most common technology used. A probable reason is that AI has the most favourable cost-benefit ratio of the reproductive biotechnologies (Thibier *et al*., 2004) and also requires comparatively less technical skill and equipment. However, in Africa and in the Southwest Pacific even AI is not practised in all countries. Constraints to the development and utilization of biotechnologies in general include a lack of financial, human and technical resources. Moreover, the provision of services such as AI often has to overcome difficulties relating to access, affordability, farmer awareness and knowledge, and the need to tailor services to the needs of livestock keepers within diverse local production systems. In the case of more complex technologies such as ET the constraints are magnified to an even greater extent. The use of reproductive biotechnologies is most widespread in cattle. The low natural reproductive rate of cattle increases motivation to develop and utilize technologies which allow the rate of genetic improvement to be increased (FAO, 1996). Moreover, the high value of the animals makes expenditure on AI or ET more economically attractive. The technical ease of deep-freezing semen and embryos is also highest in cattle (Hiemstra *et al*., 2005). However, the finding may also reflect the general pro-cattle bias which has been observed in livestock development efforts (FAO, 1993). With regard to the breeds involved, there are only a limited number of examples in the CRs of programmes which make use of biotechnologies to facilitate the development, utilization or conservation of locally adapted breeds.

While the expansion of the use of biotechnologies is clearly considered to be an important objective, many CRs express concern regarding the inappropriate use of AI. Concerns largely relate to the unplanned use of the technology to introduce exotic germplasm, which may threaten the existence of indigenous genetic resources. With regard to productive breeds kept under high external input conditions, some concerns are also expressed with regard to a narrowing of the genetic resource base. As such, there is a need for careful attention to be given to identifying appropriate policies, programmes and regulatory frameworks for the use of biotechnologies in the management of livestock breeding and reproduction. Such deliberations require good knowledge of the characteristics of the relevant genetic resources, an understanding of the production systems in question, and consideration of the above-mentioned constraints to service delivery.

Molecular genetic studies offer a potentially important tool for the characterization of livestock genetic resources. However, the use of molecular techniques to evaluate genetic resources, to plan of conservation efforts, or to facilitate the achievement of desired breeding objectives is limited or absent in most developing countries. A desire to develop greater capacity to conduct molecular genetic studies is expressed as a priority in many CRs. However, the successful application of technologies such as marker assisted selection necessitates a high level of expenditure in terms of establishment and maintenance costs, and requires skilled human resources, equipment, laboratories and supportive infrastructure (FAO, 2005). As such, the cost-effectiveness of strategies based on the use of the technologies has to be carefully evaluated.

The desire to make greater use of biotechnologies to raise livestock productivity and increase the supply of livestock products is widely expressed in the CRs from developing countries. In a number of regions, there is increasing diversity in terms of the stakeholders providing services, with greater involvement of the private sector and breeders' organizations. However, the extent to which such developments will overcome the constraints to the utilization of biotechnologies in developing countries is not clear. It is evident from the CRs that in this respect, progress is often very limited. A widespread use of biotechnology is hindered by the gaps in infrastructure, markets, breeding capacity, input delivery systems and extension services, which hinder all efforts to promote livestock development in poor, remote

areas (FAO, 2004). As such, many of those most dependent on livestock to support their livelihoods are denied the option of utilizing biotechnologies as a means of developing animal genetic resources to meet their needs. However, there is also concern that the potential of biotechnology to make a substantial contribution to poverty reduction is overrated in relation to livestock production (Bayer, 2005).

In contrast to the research that drove the Green Revolution, the majority of agricultural biotechnology research and commercialization is being carried out by private firms based in industrialized countries (FAO, 2004). This is evident in the production of genetically modified crops but also in the concentration of the market in the hands of a small number of breeding companies in the poultry sector, a development which seems to be followed in the pig industry. The dominance of the private sector in the "gene revolution" raises concerns that farmers in developing countries, particularly poor farmers may not benefit, or indeed may lose out, either because innovations are not accessible, are too expensive, or are inappropriate to their needs.

Conclusions

It is evident that there are numerous constraints and pitfalls to be overcome if reproductive biotechnologies are to make a significant positive contribution to the management of animal genetic resources in developing countries. Investment in infrastructure, and human and technical capacity building is required; and this desire is clearly expressed in many CRs. However, it is also essential that increased utilization of the technologies is well planned, has clear objectives and takes account of local conditions. To this end, improved characterization of breeds and production environments is required. Better understanding is vital to ensure that the more rapid genetic change made possible by biotechnologies is actually beneficial to livestock keepers and society, and that threats to genetic diversity are minimized. Biotechnologies will contribute little to genetic improvement unless calls for their introduction are accompanied by a vision of how they can be incorporated within targeted breed development programmes. Few programmes capable of incorporating the more advanced biotechnologies into livestock genetic improvement activities exist in developing countries at present. The situation is unlikely to change without significant public as well as private sector investment.

Constraints to the delivery, uptake and successful application of biotechnologies in developing-country conditions need to be addressed. Consideration should be given to any accompanying improvements to animal health, nutrition and management which may be necessary to achieve the desired outcomes. As well as considering impacts on genetic diversity, the short and long-term socio-economic implications of promoting the increased use of biotechnologies by small-scale producers also need to be assessed. Potentialities, constraints and problems related to the roles of alternative service providers require investigation. Livestock keepers, their associations, and relevant NGOs should be involved in the process of setting priorities for biotechnology use, the organization of breed development programmes, and in resolving problems associated with the provision of biotechnology services.

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Appendix 1. Distribution of countries by region (and dates when country reports were completed)

Africa: Algeria (October 2003), Angola (May 2004), Benin (July 2003), Botswana (November 2003), Burkina Faso (May 2003), Burundi (December 2003), Cameroon (February 2003), Cape Verde (January 2003), Central African Republic (June 2003), Chad (April 2003), Comoros (March 2005), Congo (April 2003), Democratic Republic of the Congo (January 2005), Côte d'Ivoire (March 2003), Equatorial Guinea (May 2003), Eritrea (July 2003), Ethiopia (July 2004), Gabon (March 2003), Gambia (January 2003), Ghana (October 2003), Guinea (April 2003), Guinea-Bissau (July 2002), Kenya (June 2004), Lesotho (April 2005), Madagascar (March 2003), Malawi (April 2004), Mali (September 2002), Mauritania (February 2004), Mauritius (August 2004), Mozambique (March 2004), Niger (May 2003), Nigeria (March 2004), Rwanda (May 2004), Sao Tome and Principe (May 2003), Senegal (April 2003), Swaziland (December 2004), Togo (March 2003), Tunisia (December 2003), Uganda (February 2004), United Republic of Tanzania (October 2004), Zambia (November 2003), Zimbabwe (May 2004).

Asia: Bangladesh (June 2004), Bhutan (September 2002), Cambodia (August 2003), China (June 2003), India (December 2004), Indonesia (August 2003), Iran (Islamic Republic of) (July 2004), Japan (April 2003), Kazakhstan (December 2003), Kyrgyzstan (November 2003), Laos (May 2005), Malaysia (August 2003), Maldives (September 2004), Mongolia (September 2002), Myanmar (March 2004), Nepal (January 2004), Pakistan (March 2003), Papua New Guinea (November 2004), Philippines (August 2004), Republic of Korea (March 2004), Sri Lanka (August 2002), Tajikistan (December 2003), Turkmenistan (August 2004), Uzbekistan (August 2003), Viet Nam (April 2003).

Europe: Albania (December 2002), Armenia (June 2003), Azerbaijan (December 2003), Belarus (2003), Belgium (January 2005), Bosnia and Herzegovina (2003), Bulgaria (March 2004), Croatia (July 2003), Cyprus (October 2003), Czech Republic (July 2003), Denmark (April 2004), Estonia (March 2004), Finland (January 2004), France (June 2004), Georgia (February 2004), Germany (June 2003), Greece (February 2004), Hungary (June 2003), Iceland (December 2003), Ireland (July 2003), Latvia (December 2003), Lithuania (November 2003), Netherlands (November 2002), Norway (December 2002), Poland (October 2002), Portugal (June 2004), Moldova (December 2004), Romania (December 2003), Russian Federation (December 2003), Serbia and Montenegro (March 2003), Slovakia (June 2003), Slovenia (June 2003), Spain (June 2004), Sweden (September 2002), Switzerland (December 2002), The Former Yugoslav Republic of Macedonia (November 2003), Turkey (August 2004), Ukraine (February 2004), United Kingdom (November 2002).

Latin America and the Caribbean: Argentina (September 2003), Barbados (January 2005), Bolivia (January 2004), Brazil (February 2004), Chile (December 2003), Colombia (October 2003), Costa Rica (June 2004), Cuba (March 2003), Dominican Republic (March 2004), Ecuador (December 2003), El Salvador (December 2003), Guatemala (April 2004), Haiti (October 2004), Honduras, Jamaica, Mexico (July 2002), Nicaragua (August 2004), Paraguay (June 2004), Peru (May 2004), Trinidad and Tobago (May 2005), Uruguay (December 2003), Venezuela (Bolivarian Republic of) (December 2003).

Near and Middle East: Egypt (June 2003), Iraq (January 2003), Jordan (March 2003), Oman (March 2004), Sudan (January 2004), Syrian Arab Republic (May 2003), Yemen (November 2003).

North America: Canada (February 2004), United States of America (December 2003).

Southwest Pacific: Australia (November 2004), Cook Islands (October 2003), Fiji (March 2004), Kiribati (March 2004), Northern Mariana Islands (February 2004), Palau (2003), Samoa (March 2004), Solomon Islands (February 2004), Tonga (January 2005), Tuvalu (January 2005), Vanuatu (December 2003).

The status of cattle genetic resources in North Ethiopia: On-farm characterization of six major cattle breeds

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Summary

On-farm surveys and characterisation of six indigenous north Ethiopian cattle breeds (Afar, Arado, Begait, Fogera, Medenes and Raya) was carried out with the objective of determining the current status of these breeds. Information from a structured questionnaire distributed to 450 farmers, 37 group discussions, field measurements of heart girth and height on 25 males and 25 females from each breed and secondary information were used to carry out the study. Population size of the Arado breed increased by more than three fold between 1992 and 1999, while the Raya, Fogera and Begait population decreased by 57, 27 and 67%; between 1981 and 1999 respectively. Three distinctive types were identified within the Afar and Begait breeds with different adaptation and threat levels in relation to changes to the bio-physical and social environment. Overall production and reproduction performance of the breeds in the pastoral production system (Afar and Begait) was higher than the Raya and Medenes, and Arado and Fogera breeds of the agro-pastoral and mixed crop/livestock production systems respectively. Extinction probability for most of the breeds was high, the highest (0.67) being for the Begait breed. On the other hand, except for the initiative taken to evaluate, improve and conserve the Fogera breed at the Metekel and Andasa cattle breeding ranches, there are no institutionalized attempts towards improving and/or conserving the other breeds.

Resumen

Se llevó a cabo una serie de encuestas sobre el terreno sobre caracterización de seis razas bovinas indígenas del norte de Etiopía (Afar, Arado, Begait, Fogera, Medenes y Raya) con el objetivo de determinar la situación actual de estas razas. Se utilizó la información proveniente de un cuestionario estructurado distribuido a 450 ganaderos, 37 grupos de discusión, medidas tomadas sobre el terreno de circunferencia torácica y altura de 25 machos y 25 hembras de cada raza así como información secundaria utilizada para el estudio. El tamaño de la población de la raza Arado se incrementó por más de tres veces entre 1992 y 1999, mientras que las razas Raya, Fogera y Begait disminuyeron de 57, 27 y 67%, respectivamente, entre 1981 y 1999. Se identificaron tres tipos diversos entre las razas Afar y Begait con diferente adaptación y niveles en relación a los cambios biofísicos y de entorno social. La producción global y rendimiento de reproducción de las razas Afar y Begait en el sistema pastoral fue superior al de las razas Raya y Medenes, y de las razas Arado y Fogera en sistema agropastoral y mixto en sistemas de agricultura/ganadería. La probabilidad de extinción para muchas de las razas fue elevada, la mayor (0,67) correspondía a la raza Begait. Por otra parte, salvo por las iniciativas tomadas para la evaluación, mejora y conservación de la raza Fogera en la zona de Metekel y Andasa, no existen intentos institucionalizados con el objetivo de mejorar y/o conservar las demás razas.

Keywords: *Cattle, Genetic resource, On-farm, characterization, Ethiopia, Extinction, Afar, Arado, Begait, Fogera, Medenes, Raya.*

Introduction

Cattle production has been a crucial part of the production and livelihood systems of the north Ethiopian population as providers of food, draught power and as important hedge during crop failure and drought periods, accumulation of assets and other socio-cultural functions. The north Ethiopian region has been a centre of some of the longest civil wars in Africa and this has led among other things, to the accelerated destruction of eco-systems and natural resource degradation resulting in recurrent drought and famine.

There have been little or no efforts exerted to study the animal genetic resources in general and

cattle breeds in particular that have been utilised in the different production systems of the region, which are believed to have close to 50% of the genetic diversity in the country. Due to the fact that there have been major socio-political (civil wars and urbanization) and environmental (drought and destruction of ecosystems) changes in the last 25 years, useful information such as population sizes on most of the cattle breeds is not available and unfortunately most studies seem to have used breed population data that are too old to describe the current status of animal genetic resources in the region.

A recent estimate of extinction probability for 49 African breeds (Reist-Marti *et al*., 2003) showed that half of the cattle diversity in Africa will be lost in the next 20-50 years if no conservation efforts are made.

The objective of this paper was therefore to provide information on the current status, threat of extinction and on-farm characterisation of the Afar, Raya, Arado, Begait, Medenes and Fogera breeds found in north Ethiopia based on an on-farm characterisation and field measurement.

Materials and Methods

Study area and data collection

The present survey was carried out in six major breeding areas of the six breeds studied: the northern part of the Afar region for the Afar breed; central, southern and western zones of Tigray region for the Arado, Raya, Medenes and Begait breeds respectively; Bahirdar Zuria zone, Andasa and Metekele cattle breeding centres of the Amhara region for the Fogera breed (Figure 1).

The survey was conducted in four villages of the Alamata district of south Tigray (Kelkala, Selienwuha, Fatcha and Gerjele), four villages of the Ahferom district in central Tigray (Igella, Gerhusernay, Semhal and Irdijeganu), three villages of Tahtayadiabo district in west Tigray (Aditsetser, Adiaser, Maykuhli and Gemhalo), four villages of the Abala district, North Afar region (Kala, Weqrigubi, Irebti and Irkudi) and three villages in the Bahirdar Zuria district Amhara region (Kidisthana, Wagtera and Shada) and two cattle breeding centres (Andasa and Metekel).

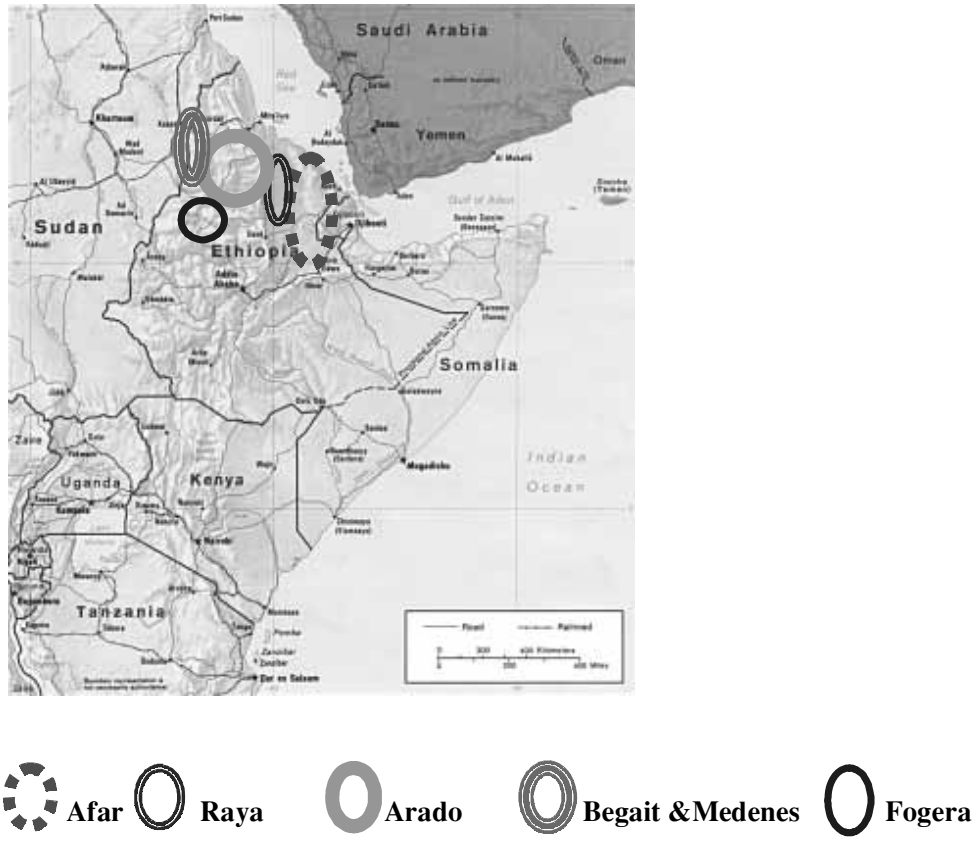

Figure 1. Geographical location of the study and major breeding areas

Villages for this study were selected based on information from the respective regional offices of the Ministry of Agriculture, while cattle owners in those villages were selected randomly. Two cattle breeding centres (Andasa and Metekel) were also included.

An average of 75 cattle owners from each breed were interviewed based on a structured questionnaire designed to collect data for each of the six breeds studied and formal group discussions were conducted. The questionnaire was designed to collect data on the origin of the breeds, physical descriptors, their main purpose, productive and reproductive performance, management and breeding practices, population trends, uniqueness (special traits), farmers' preference and opinions on comparisons of these breeds with other breeds known to the cattle owners. The Arado breed was compared with Begait and Medenes, the Afar breed with Raya and the Fogera breed was compared with highland zebu cattle for 15 traits of economic and adaptive importance. The formal group discussions focussed on general issues such as:

1. status of the breed;
2. breeding management and goals;
3. awareness of diversity;
4. population trends and major threats to the breed.

Three group discussions with 7-10 farmers in each group, were conducted in each village. Information on the bio-physical conditions and production environment (Table 1) and size of breed population (Table 2) was compiled from reports of earlier surveys (BoNAR, 1999; FAO DAD-IS, Haile and Kebede, 1996; Tekleab, 2000; Rege, 1999; Rege and Tawa, 1999; Woldu, 1999). A questionnaire developed for an on-farm characterization of other breeds (Zerabruk and Vangen, 2005) was used in the present study.

Height at withers and heart girth measurements of 25 males and 25 females of each breed were recorded and pictures were taken from representative animals. Adult body weight was estimated from heart girth measurements (Daltons supplies Ltd).

Cattle breeds

Six major breeds found in north Ethiopia - the Afar, Arado, Raya, Begait, Medenese and Fogera - have been included in the present study. The Afar and Begait, Raya and Medenes, and Arado and Fogera are reared in the pastoral, agro-pastoral and mixed crop/livestock production systems respectively (Table 3).

The Afar breed is mainly found in the north-eastern lowlands of the Afar and adjacent regions of Ethiopia. It is adapted to the arid and semiarid range land conditions and to the pastoral and/or agro-pastoral way of life of the Afar people. The breed is mainly reared for its milk production (Albero and Hailemariam, 1982; Rege, 1999).

The Raya breed is found in the south-eastern lowlands and adjacent part of Tigray region, Ethiopia. It is believed to be a variety of the Afar breed adapted to the crop/livestock production system of the area. The breed is popular and reared for its draught power and meat. The Afar and Raya breeds belong to the East African sanga breeds cluster and are further grouped with the Abyssinian sanga breeds (Rege, 1999).

The Arado breed is found widely distributed in the northern highlands of Ethiopia and adjacent areas in Eritrea. It is mainly reared for draught power. The breed subsists mainly on crop residues and is well adapted to seasonal feed shortages associated with the mixed crop/livestock production system in the area (Rege, 1999; Tekleab, 2000).

The Fogrea breed is found in the surrounding area of the Lake Tana region and mainly distributed along the vast area of the Fogera plain, in the north-west highlands of Ethiopia. The breed is popular for its adaptation to seasonal flooding and the swampy conditions of the area. It is reared for its draught and dairy production abilities. The Arado and Fogera breeds belong to the Zenga group (Zebu-sanga cross-bred) (Albero and Hailemariam, 1982; Rege, 1999).

The Medenes breed is a relatively new breed and a result of cross breeding between the Arado and Begait breeds. It is found in the western highlands of Tigray and is bred for both milk and draught purposes (Tekleab, 2000).

The Begait (also known as Barka) breed is found in the western lowlands of Eritrea and north-west of Ethiopia. Animals of this breed are popularly bred for milk production and play an important role in the livelihood of the pastoral and agro-pastoral people in the area. The Begait breed belongs to the cluster of the north Sudan Zebu breeds (Albero and Hailemariam, 1982; Rege, 1999; Tekleab, 2000).

Extinction probability

Extinction probability for the six cattle breeds within the next 20-50 years was calculated using a method described by Reist-Marti *et al*. (2003) as:

Table 1. Characteristics of the major production environment of six indigenous cattle breeds of north Ethiopia[1].

Breed	Agro ecological zones	Altitude m.a.s.l	Major vegetation types	Dominant soil types	Production system
Afar	Hot to warm arid lowland plains	<1400	Bushland, riverine acacia	Solonchacks/ Fluvisols	Pastoralism
Arado	Tepid to cool semi-arid mid highlands	1500-2500	Bushland and cultivation	Cambisols/ Leptisols	Crop/Livestock
Begait	Hot to warm semi-arid lowlands	500-1500	Bushland & grassland.Ballanites, Zeziphus,Boswellia, riverine	Vertisols	Pastoralism
Fogera	Tepid to cool moist mid-highlands	1500-2500	Bushland and cultivation	Vertisols/Luvisols/ Fluvisols Seasonally flooded	Crop/Livestock
Raya	Hot to warm sub-moist lowlands	500-1500	Bushland & cultivation. Acacia, Ballanites, Zeziphus and cactus	Vertisols/Fluvisols/ Leptisols	Agro-pastoralism, Crop/Livestock
Medenes	Hot to warm semi-arid lowlands	500-2000	Bushland and cultivation	Vertisols, Cambisols	Agro-pastoralism, Crop/Livestock

[1]Sources: Haile, and Kebede (1996), Woldu (1999).

Table 2. Distribution and population size of six indigenous cattle breeds of north Ethiopia.

Breed	Village	Population size[1]	Population size[2]
Raya	• Rayaazebo	111 019	
	• Alamata	67 684	
	• Wajerat	23 266	
	• Others	23 709	
	Total	225 678	521 000 (1992)
Arado			
	Total	1 426 644	440 000 (1992)
Begait	• Tahtayadiabo	32 132	
	• Kaftahumera	13 755	
	• Welqait	10 698	
	• Asgedetsimbla	7 328	
	• Others	12 793	
	Total	76 706	
Medenes	• Tahtayadiabo	29 042	
	• Asgedetsimbla	23 946	
	• Tselemti	3 838	
	• Welqite	3 835	
	• Tsegede	3 232	
	Total	63 893	
Begait(Begait and Medenes)		N/A	850 000 (1981)
Afar		N/A	680 590 (1992)
Fogera		N/A	868 000 (1992)
			636 000 (1998)

[1](BoNAR, 1999).
[2](FAO DAD-IS).

$$z_i = \frac{0.8}{1.2} * \sum_{a=1}^{10} z_{ia} + 0.1$$

Where is the extinction probability of breed $_i$ computed as the sum of the value of ten variables rescaled to a value between 0.1 and 0.9.
This method compared to other risk assessment methods (Rege, 1999; Scherf, 2000), uses a scheme with ten breed specific variables considered important to evaluate the threat of extinction of a given breed (Table 5). However, one out of the ten variables used to derive extinction probability (political situation of the country) was modified to reflect the direct impact of war and conflicts on animal genetic resources rather than the one ("security information for travellers") used by Reist-Marti *et al*. (2003). Two of the ten variables (population size and population size change) were derived from population size information of a livestock census (BoNAR, 1999) and from the FAO DAD-IS data base. The remaining variables were derived from information collected in the present study.

Result and discussion

Population size and description

Population size and distribution of the breeds studied are given in table 2. Population data for the Raya, Arado, Begait, and Medenese were obtained from the Tigray regional livestock census report (BoNAR, 1999). Data from the global data base (DAD-IS) was used for the Afar and Fogera breeds for lack of recent information for comparative purposes.

Except for the Arado, Medenes and Afar breeds, all interviewed farmers indicated a dramatic decrease in population size over the past 20-30 years. The Raya and Fogera breed population sizes have decreased by 57% and 27% respectively between 1992-1999, (Table 2).

The situation with the Begait breed is even more alarming. Even if we combine the Begait and Medenes populations in Ethiopia and assume there is about the same size in Eritrea, the population size has decreased by 67% between 1981 and 1999 due to two major famines in the area in 1984/1985 and

Table 3. Mean and standard deviation for production, reproduction, body weight[1] and height measurement traits in six indigenous cattle breeds of north Ethiopia.

Trait	Afar n (100) $\overline{X}$ ± S.D	Raya n (100) $\overline{X}$ ± S.D	Arado n (100) $\overline{X}$ ± S.D	Medenes n (75) $\overline{X}$ ± S.D	Begait n (75) $\overline{X}$ ± S.D	Fogera n (100) $\overline{X}$ ± S.D
Milk yield/day (kg)	4±1	3±1	1.8±0.4	2.5±1	5±0.5	2±0.7
Lactation length (days)	271±22	210±17	242±20	162±29	205±32	159±24
Age at 1st calving (mo)	37±11	41±10	50±7	42±8	38±5	44±6
Calving interval (mo)	14±2	15±3	22±3	19±5	16±2	20±4
Adult body weight (kg)						
• Male	298±43	281±41	254±46	260±23	333±51	301±28
• Female	224±17	219±26	201±39	248±21	278±41	265±20
Adult height (cm)						
• Male	124±4	122±4	114±3	117±3	131±4	137±9
• Female	115±4	113±4	108±4	115±2	125±4	118±4

[1]Body weight is estimated from heart girth measurements.

1995/1997. According to Sanford and Yohannes (2000) a 72, 60 and 78% decline in cattle population was reported for the Afar region during the 1972/1974 famine, the 1984/85 famine in the Borena area of south Ethiopia and the 1995/1997 famine in Somali and Borena regions respectively. A more than 70% reduction in population size was recorded between May 1999 and May 2000 in the southern Somali and Borena regions (Devereux, 2000). Currently, the populations of most of the breeds studied and other small ruminant breeds are under extreme pressure as a result of increased demand for meat from the presence of a huge number of army personnel in the northern part of the country since the 1998 border war between Ethiopia and Eritrea.

Afar

Most of the interviewed pastoralists (89%) indicated that the Afar breed is native to the region while the remaining 11% believed the breed migrated from present day Yemen across the Red Sea. According to results from group discussions, three distinct types of the Afar breed namely Bedaeru, Igahiboda and an intermediate between the two have been identified.

The Bedaeru type is described as a relatively small sized animal with short horns, higher milk production, a tolerance for drought and feed shortages and adaptation to the hot, flat dry land areas of the Bada and Afdera plains of the region. They have mostly a grey or white smooth and shiny coat colour. The population size of this type is small and is decreasing, according to interviewed pastoralists.

The Igahiboda is a large sized animal with large lyre shaped horns, suited for both the dry lowlands and adjacent highlands. This type is found in Abala, Megale, Irebti and Berahle of the Afar region and Raya and Wajerat of the Tigray region. This type is phenotypically similar to the Raya breed (Figure 2 and 3).

The intermediate type is medium sized, mostly with a red coat colour and is found mainly in the Dalol and Kuneba areas of north Afar.
Nearly all information from interviewed pastoralists and results from the group discussions indicated that the overall population size of the breed is increasing due to the availability of vaccinations against major cattle diseases such as reinderpest, CBPP and anthrax, regardless of the chronic droughts in the area. Moreover, change in the rangeland condition has favoured cattle rearing compared to camel and goat production which used to dominate the pastoral production system (Diress, *et al*.2003). This change has led cattle breeders towards the development and utilization of conventional breeding practices (identification, selection, controlled breeding).

Raya

The Raya breed is believed to have originated mainly in the adjacent parts of the Afar region. 93, 5 and 2% of respondents believed the origin to be from the Afar, the result of introduction following

Table 4. Comparisons by farmers among six indigenous cattle breeds of north Ethiopia for some traits of importance.

Trait	Comparison	Arado vs Begait	Arado vs Medenes	Begait vs Medenes	Raya vs Arado	Afar vs Raya	Fogera vs Highland
Body size	Smaller	100	87	-	-	-	-
	Comparable	-	13	7	-	8	-
	Larger	-	-	93	100	92	100
Age at first calving	Younger	3	16	21	68	84	75
	Comparable	19	31	32	19	16	25
	Older	78	43	47	13	-	-
Calving interval	Shorter	-	6	3	86	96	42
	Comparable	27	11	86	12	4	38
	Longer	73	83	11	2	-	20
Milk yield	Higher	-	2	93	100	100	97
	Comparable	-	7	7	-	-	3
	Lower	100	91	-	-	-	-
Lactation length	Longer	39	13	96	100	100	100
	Comparable	42	69	4	-	-	-
	Shorter	19	18	-	-	-	-
Milk fat percentage	Higher	68	26	28	29	89	91
	Comparable	24	71	64	45	11	6
	Lower	18	3	8	26	-	3
Draught power	Better	-	56	13	100	-	97
(speed & length of	Comparable	11	29	72	-	17	3
working hours)	Worse	89	15	15	-	83	-
Disease resistance	Better	72	69	-	12	69	-
	Comparable	28	25	17	77	26	16
	Worse	-	6	83	11	5	84
Tick resistance	Better	63	88	9	-	9	12
	Comparable	29	11	24	95	26	88
	Worse	8	1	67	5	65	-
Feed shortage	Better	100	100	-	-	37	17
	Comparable	-	-	2	39	32	67
	Worse	-	-	98	61	31	16
Watering frequency	Better	-	35	95	88	98	21
	Comparable	9	49	5	8	2	79
	Worse	91	16	-	4	-	-
Grazing	Better	7	2	99	93	100	78
	Comparable	37	21	1	7	-	22
	Worse	56	77	-	-	-	-
Meat quality	Better	83	63	-	-	-	6
	Comparable	14	19	11	6	56	23
	Worse	3	18	89	94	44	71
Hide quality	Better	96	81	-	-	-	2
	Comparable	4	16	3	11	19	9
	Worse	-	3	97	89	81	89
Market value of live	Better	-	-	57	97	16	47
animals	Comparable	2	37	43	3	71	38
	Worse	98	63	-	-	13	15

Figure 2. Afar cow (Igahiboda type) Mayshiguala river, Abala, Afar, Ethiopia.

Figure 3. Afar bull (Igahiboda type) Abala, Afar, Ethiopia.

the Oromo migration of the 16th to 17th century and indigenous to the area respectively (Figure 4).

Begait

In the case of the Begait breed, 91 and 9% of respondents indicated the place of origin of this breed to be the Sudan and the lowlands of Eritrea, respectively. Two distinct types of the breed have been identified according to the group discussions.

The Dohin, is a tall and slender type with short ears, a straight nose, a narrow long neck and long thin legs, a long tail, a less developed dewlap and a smaller udder (Figure 5). Milk production is lower than in the other type. Both males and females have thin and medium horns, with black or brown coat colour. The most important traits of this type are its aggressive behaviour towards intruders which is an advantage in areas where cattle rustling is a big problem, and the capacity to travel long distances and graze in the vast range lands.

The Begait type is the largest and most docile with a well developed udder, long teats and a higher milk yield. Small and stumpy horns are common in both males and females of this type. The Begait is very vulnerable to food shortage. Grey, brown and black and white coat colours are most common (Figure 5, 6 and 7).

Medenes

The Medenes is a crossbred of the Begait and Arado breeds (almost always a cross between Arado cow with Begait bull). They are medium sized with large ears, and are mostly black and white in varying patterns, other colours being rare (Figure 8). This type is tolerant to food shortage but milk production is lower than the Begait and is comparable with the Dohin type.

Arado

The origin of this breed is less well known. Sixty seven percent of interviewed farmers do not know the origin of this breed, 12 and 21 % of the respondents indicated that the breed is indigenous and as a result of introduction from the lowlands respectively. The breed is characterised as small and hardy with red and black coat colours in abundance. Females have medium, thin horns while males have thicker and shorter horns and a cervicothoracic hump (Figure 9 and 10). This breed

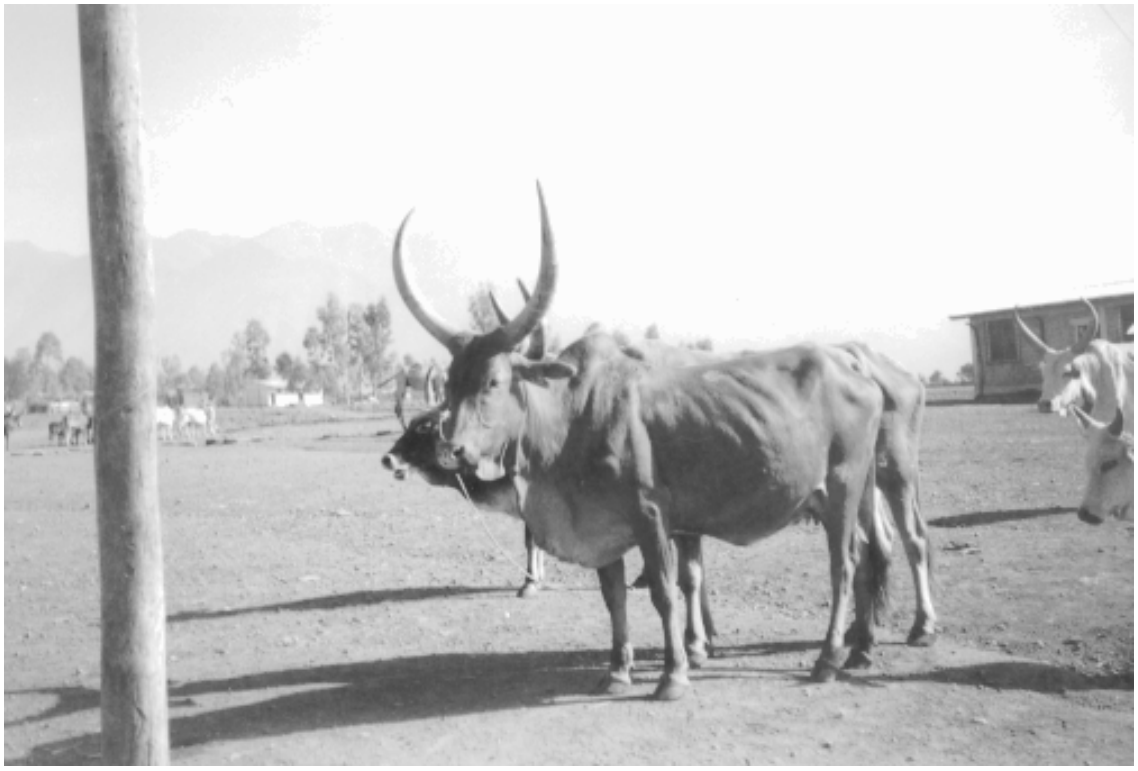

Figure 4. Raya cow, Alamata, Tigray, Ethiopia.

Figure 5. Begait cow (Dohin type), Adiremets, Tigray, Ethiopia.

Figure 6. Begait cow (Begait type), Tekeze river, Adiremets, Tigray, Ethiopia.

Figure 7. Begait bull (Begait type), Sheraro, Tigray, Ethiopia

is the most abundant and heterogeneous breed of cattle in the highlands and most influenced by such factors as introduction of bulls from the lowland breeds, and bull and AI services introduced by different projects.

Fogera

All interviewed farmers believe that this breed is indigenous to the area. The breed is characterised as medium to large in size with short or stumpy horns, a well developed dewlap, a navel flap and udder in females and a small to medium thoracic hump in males and females. Black with small spots of white is the most dominant coat colour (Figure 11 and 12).

Production and Reproduction

The production and reproduction performance information from the questionnaire and group discussions, and body weight and height measurements are summarised in table 4. Males and females of the Begait breed were heavier and taller than the other breeds. Body weights and heights for Begait and Afar in the present study were smaller and marked differences between the sexes in the Afar breed were observed compared to earlier reports (FAODAD-IS). The average daily milk production for Begait was higher than all breeds, while the lactation length was shorter than the Arado, Afar and Raya breeds. The age at first calving for the Afar and Begait were 10, 26, 12 and 16% shorter than the Raya, Arado, Medenes and Fogera respectively; the calving interval for the Afar was 7, 36, 26, 14 and 30% shorter than Raya, Arado, Begait, Medenes and Fogera breeds respectively. Overall productivity of breeds from the pastoral production system (Afar and Begait) seems to be higher than the breeds from the agro-pastoral system (Raya and Medenes) and the crop/livestock production system (Arado and Fogera).

According to results from the group discussions, two outstanding factors - relative abundance of feed in the range lands and the knowledge and practice of selective and controlled breeding in pastoral communities - were identified to have contributed to the differences in the performance of the breeds with respect to the production system.

Breeding and genetic resource management

Except for the initiative taken to improve and conserve the Fogera breed, there are no known

Figure 8. Medenes cow, Aditseser, Tigray, Ethiopia.

institutionalised activities for the benefit of the other breeds. The farmers and pastoralist are doing their best to manage their resources albeit under extremely difficult circumstances with no technical or other forms of support.

There was a marked difference in the general awareness of genetic resources management and utilization of inter and intra breed genetic variation between the pastoral and agro-pastoral communities in the lowlands, and the farmers in the highlands.

One hundred, 78 and 91 percent of the interviewed farmers/ pastoralists indicated that they use traditional methods of animal identification, controlled breeding and culling unwanted males before sexual maturity based on family information for the Afar, Raya and Begait breeds respectively. Only 7, 38 and 21% of interviewed farmers indicated the use of traditional methods to improve their animals for the Arado, Medenes and Fogera breeds respectively. Intra-breed selection and controlled breeding are favoured as methods for genetic improvement by Afar, Raya and Begait breeders, while crossbreeding is considered to be the best method in the case of Arado, Medenes and Fogera breeders.

It was further observed in the group discussions that there is the presence of a collective sense of breed ownership and awareness in the Afar, Begait and (to a lesser extent) Raya breeders, whereby traditional mechanisms are used to protect and maintain their genetic resource from the effects of migration from adjacent breed populations. Such traditional systems were generally absent in the case of Arado and Fogera breeders.

Traits of adaptive and economic importance

According to interviewed farmers/pastoralists, the cattle breeds studied have traits of adaptive importance for their respective production systems. A very important observation in this study is pastoralists' and farmers' utilization of intra-breed genetic variation in their breeding systems to develop distinct types (the Bedaeru and Igahiboda types of the Afar breed, and the Dohin and Begait types of the Begit breed) within a breed that are suitable for a range of environmental conditions.

This practice, however, in addition to the effects of natural selection for fitness, tend to favour the intermediate types that can adapt well to broader environmental and farming system conditions as opposed to types with specific merits or high performers in a given niche.

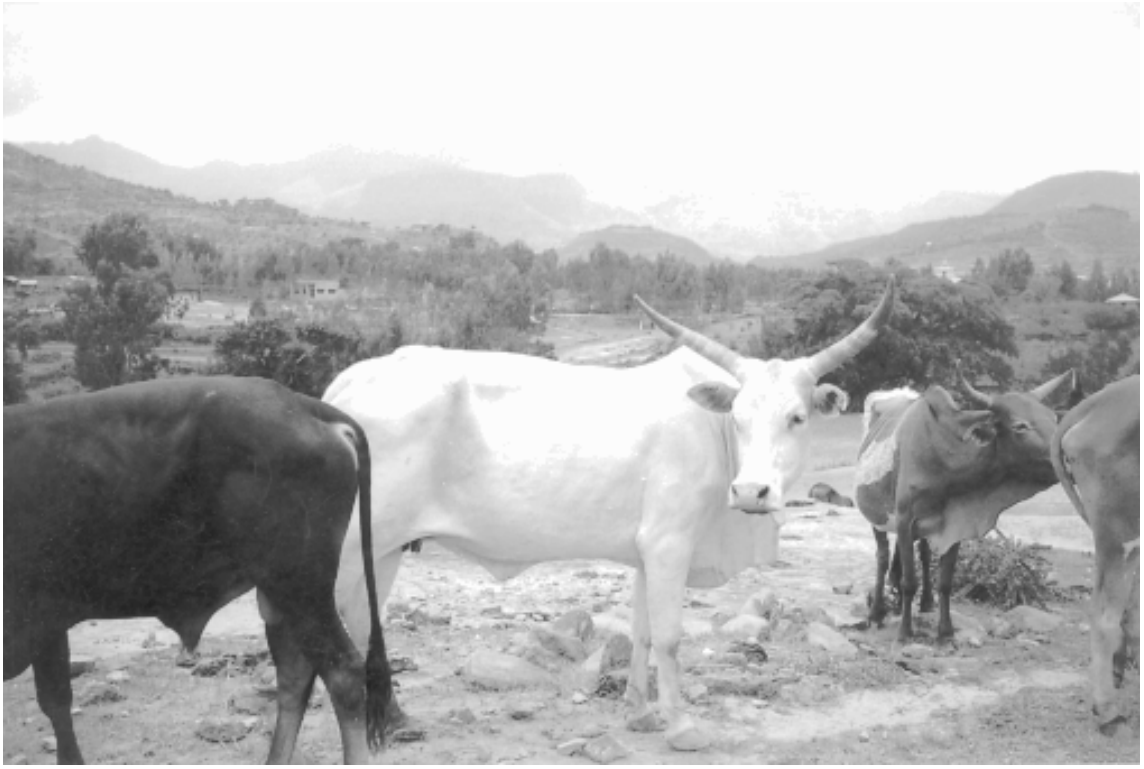

Figure 9. Arado cow, Enticho, Tigray, Ethiopia.

Figure 10. Arado bull, Gerhusernay, Tigray, Ethiopia.

Table 5. Variables and criteria for the estimation of the extinction probability of African cattle breeds. (Reist-Marti et al. 2003).

Variable (abbreviation)	Criterion and value
Total population size (POS)	0.3 < 1 000
	0.2 = 1 001-10 000
	0.1 = 10 001-100 000
	0.0 > 100 000
	0.1 = missing value
Change of total population size over the last 10 years (CHA)	0.1 = decreasing (>20%)
	0.0 = increasing or stable
Distribution of the breeds (DIS)	0.1 = localized (in 1 or more countries)
	0.05 = spread within 1 country
	0.0 = widespread over several countries
	0.0 5 = missing value
Degree or risk of indiscriminate crossing (CRO)	0.1 = high
	0.0 = marginal
	0.1 = missing value
Organization of farmers (ORG)	0.1 = no
	0.0 = yes (e.g., herd book)
	0.1 = missing value
Established conservation scheme (CON)	0.1 = none
	0.05 = partial
	0.0 = yes
Political situation of the country(-ies) (POL)[1]	0.1 = general advice against travel (war)
	0.05 = some objections (conflict)
	0.0 = no objection (no conflict)
Special traits (SPE)	0.1 = none
	0.0 = yes (e.g., trypanotolerance, adaptation to the environment)
	0.1 = missing value
Social importance (CUL)	0.1 = none or can easily be replaced by other breeds
	0.05 = some sociocultural value
	0.0 = yes (e.g., religion, traditional custom)
	0.05 = missing value
Reliability of the information (REL)	0.1 = not reliable
	0.0 = reliable
	0.1 = missing value

[1]For the present study, the variable political situation of the country/ies (POL) is modified to reflect direct threats such as war and conflicts in the immediate vicinity of the breeds instead of "security information for travellers". The criteria and value were: war =0.1, conflict= 0.05 and no conflict= 0.0.

The creation of the Medenes breed in the last 50 or so years is an indication that farmers and agro-pastoralists are changing their breeding goals from high yielding to more adaptive types by exploiting inter-breed genetic diversity. As such animals have adaptive advantages they are replacing the pure breeds.

The adaptation of the Fogara breed to survive several months in flooded areas, adaptation of the Arado and Medenes breeds to extreme feed shortage in the dry season and the adaptation of the Afar and Begait to arid and semi-arid conditions are particularly important and unique.

Threats of extinction and genetic conservation

The overall average extinction probabilities within the next 20-50 years for all breeds in the present study was 0.49±0.09, slightly higher than earlier reports (0.48±0.11) for 49 African breeds including some of the breeds in this study (Reist-Marti *et al.*,

Table 6. Estimated extinction probabilities (z) of eight indigenous cattle breeds of north Ethiopia.

		Variable[1]										
Breed	Breed group[2]	POS	CHA	DIS	CRO	ORG	CON	POL	SPE	CUL	REL	z
Afar	Sanga[a]	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.05	0.10	0.47
Raya	Sanga[a]	0.00	0.10	0.05	0.00	0.10	0.10	0.05	0.10	0.05	0.00	0.47
Fogera	Zenga[a]	0.00	0.10	0.05	0.00	0.10	0.00	0.00	0.10	0.05	0.10	0.43
Abergelle	Zenga[b]	0.10	0.10	0.10	0.00	0.10	0.10	0.00	0.10	0.05	0.00	0.53
Arado	Zenga[a]	0.00	0.00	0.00	0.10	0.10	0.10	0.05	0.00	0.05	0.00	0.37
Irob	Zenga[b]	0.10	0.10	0.00	0.10	0.10	0.10	0.05	0.10	0.05	0.00	0.57
Medenes	Zenga[c]	0.10	0.00	0.10	0.00	0.10	0.10	0.05	0.00	0.05	0.00	0.43
Begait	Zebu[a]	0.10	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.05	0.10	0.67
			Sanga			Zenga			Zebu		All	
	Average z		0.47			0.47			0.67		0.49 ± 0.09	

[1]Variables and criteria for the estimation of the extinction probability of African cattle breeds (Reist *et al.* 2003), refer table 5 for detailed description.

[2]Breed group classification according to [a] (Rege, 1999); [b] (Zerabruk & Vangen, 2005); [c](Tekleab, 2000).

Figure 11. Fogera cow, Andasa cattle breeding centre, Amhara region, Ethiopia.

Figure 12. Fogera bull, Kidisthana, Amhara region, Ethiopia.

2003). Extinction probabilities ranged from 0.37 for the Arado to 0.67 for the Begait breed (Table 6).

On the other hand, according to the information in the FAO DAD-IS and the global criteria for determining domestic animals at risk, none of the breeds studied is considered to be at risk (Scherf, 2000).

While the overall approach of estimating extinction probabilities by this method can be relatively effective, as it includes more variables in studying threat levels of breeds, its accuracy depends mainly on the availability of current population data and deriving variables and values that directly influence the threat level of each of the breeds studied in their respective production environment (Table 5).

Population size has dramatically changed in the last 20-30 years for most of the breeds studied and in many cases the same population data was used to estimate extinction probability and risk of extinction. Although the average overall extinction probability for all breeds in the present study is very close to earlier estimates (Table 6), the extinction probability of the Raya breed was higher and that of Arado was lower than reported (Reist-Marti *et al.*, 2003). Hence, extinction probability and expected loss of diversity should be updated based on the most recent information and using relevant variables to ensure successful monitoring of animal genetic resources.

However, the more than threefold increase in the population size of the Arado, while most of the other breeds had marked reductions during the same period, indicates more productive breeds such as the Begait and Raya and more productive types within breeds such as the Igahiboda type of the Afar breed are declining in numbers and being replaced by less productive breeds and types.

The high overall extinction probability for most of the breeds in this study indicates the need for urgent intervention in terms of breed conservation efforts. The only effort so far is the in-situ conservation program for the Fogera breed at the Andassa and Metekel cattle breeding ranches. Upgrading the recording system and the use of cryopreservation of semen and/or embryos could be an alternative method of conservation for the long term.

On the other hand, the fate of the rest of the breeds is in the hands of their owners. The Afar, Begait and to a lesser extent the Raya are protected by the traditional indigenous animal genetic resources management systems of the pastoralists. As a result, the biggest threat to these breeds is not cross breeding or replacement, but natural and man made disasters such as famine and war. The Arado and to a lesser extent the Fogera are threatened by natural and man made factors, a lack of indigenous animal genetic resource management by farmers and indiscriminate cross breeding projects.

Lack of resources for farmers and government institutions forced both to focus on averting pressing short term food shortages rather than a long term effort on conservation and utilization of genetic resources.

Conclusions

Overall production and reproduction performances of cattle breeds in the pastoral and agro-pastoral production systems (Afar, Raya, Begait) were higher compared to breeds from the mixed crop/livestock production system. The six cattle breeds evaluated in the present study were found to have adaptive advantages and unique traits suited to their respective production systems. While traditional animal genetic resources management practices are part of the pastoral and agro-pastoral cattle owners approach to farming and continue to play considerable role, farmers in the mixed crop/livestock production system are less aware of similar practices. Traditional animal breeding in the form of sire and dam selection, culling and animal identification are used in genetic improvement in the pastoral and agro pastoral communities. Such practices in general are absent in the mixed crop/livestock production system and the preferred method of improvement there is cross breeding. This can partly be explained by the fact that fewer numbers of cattle are owned by farmers as compared to pastoralists, with which to undertake any meaningful selection.

Except for the Arado breed, all the breeds have gone through significant population size reductions as a result of famine and man made problems in the past 20-30 years. Famine, conflict, poverty and uncontrolled breeding (especially in the mixed crop/livestock production system) were identified as the most important threats to the cattle breeds studied.

The higher risk of extinction of the breeds especially the Begait breed (the only breed in the zebu group) calls for immediate action to save the breed.

Even though farming communities in northern Ethiopia have been the guardians for a number of plant and animal genetic resources with their indigenous knowledge, they are currently faced with problems that are complex and demand an

urgent intervention that combines modern approaches (*in-situ /ex-situ* conservation) and the utilisation of the traditional knowledge of farmers and pastoralists. Educating farmers and pastoral communities and other stake holders as well as learning from them about the challenges and opportunities of animal genetic resources should be a vital part of the battle against the extinction or loss of these valuable breeds.

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Acciones para la caracterización y conservación del bovino criollo Peruano (*Bos taurus*)

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Resumen

Se describen las actividades de conservación y caracterización del bovino criollo peruano en el Instituto Nacional de Investigación y extensión Agraria (INIEA), las mismas que se han desarrollado con la activa interacción con las comunidades rurales de las regiones peruanas de Ancash, Apurímac, Ayacucho, Junín y Puno, dedicadas a la crianza de ganado criollo; en las comunidades también se llevaron a cabo trabajo de campo y charlas participativas sobre la conservación de sus morfotipos locales. Las actividades desarrolladas incluyen la caracterización morfológica y molecular empleando microsatélites y RFLP para detectar genotipos de proteínas lácteas (variantes de kappa caseínas y beta lactoglobulinas). Esta información será de utilidad para los programas de mejoramiento del bovino criollo peruano en las comunidades rurales.

Summary

The article describes the activities relating to the conservation and characterisation of Peruvian Criollo cattle at the Instituto Nacional de Investigación y Extensión Agraria (INIEA). These activities were developed in consultation with rural communities in the Peruvian regions of Ancash, Apurímac, Ayacucho, Junín and Puno, that are dedicated to breeding Criollo cattle. Fieldwork and participative lectures about the conservation of their local breeds are also taking place in these communities. The activities include morphometric and molecular characterisation using microsatellites and RFLP to detect milk protein genotypes (kappa caseins and beta lactoglobulins variants). This information will be used by breeding programs for the Peruvian Criollo cattle in rural communities.

Palabras clave*: Criollo Cattle, Conservation, Characterisation, Peruvian Regions.*

Introducción

El bovino criollo en el Perú se originó a partir de los cruces de razas bovinas introducidas por Cristóbal Colon en América en su segundo viaje, en 1493 (Primo, 1992); en la actualidad los bovinos criollos en nuestro país son un conjunto de poblaciones muy heterogéneas, con numerosos morfotipos y adaptaciones locales escasamente estudiadas. Actualmente, el Perú cuenta con una enorme población no censada de bovinos criollos que habitan en zonas donde el medio ambiente presenta características difíciles, como el Altiplano o en regiones aisladas geográficamente en los valles interandinos; según Rosemberg (2002), el 85.8% de los 4 495 263 bovinos existentes en nuestro territorio, corresponden a animales sin raza definida, entre los cuales se encuentran el bovino criollo.

Estos animales, también denominados "*chuscos*", cumplen un rol importante en la vida de las comunidades campesinas: son fuente de proteínas (carne, leche, queso), de fuerza de trabajo, de ahorro (cotidianamente venden el queso que se produce con la leche o en casos de emergencia o necesidad de liquidez, venden a los animales mismos), fertilizantes, cuero, entre otros. Los diversos ecosistemas a los cuales se han adaptado, los hacen de gran valor potencial como fuente de genes útiles (genes de resistencia a enfermedades, de

rendimiento productivo y reproductivo, etc.); y servicios ambientales (contribuyen al manejo apropiado de hábitats seminaturales) (Rege y Gibson, 2003).

En los sistemas tradicionales de producción y mejoramiento genético existe un prejuicio por los animales criollos, considerándolos como un recurso marginal que debe ser sustituido por especies y razas exóticas mejoradas (Perú, 2004). La política nacional de desarrollo ganadero, propone el incremento de la productividad a partir de la importación de reproductores con una alta tasa productiva pero con poca o ninguna adaptación a las condiciones extremas de los Andes del Perú; también se comercializa semen importado de EEUU de toros de las razas Holstein, Brown Swiss, Aberdeen Angus, Jersey, entre otros (Perú, 2004). Ello estaría provocando procesos de erosión genética con la probable pérdida de genes de resistencia y/o adaptación y reemplazados por otros seleccionados para sistemas de producción con una elevada relación consumo/producción. Además se deja de aprovechar la condición de raza primaria del bovino criollo peruano; en ausencia de programas de selección y mejora, se pierde el potencial que significa las adaptaciones locales y su facilidad para aprovechar mejor los recursos de su difícil ambiente. Esta problemática es agraviada por los pocos trabajos de investigación en caracterización y estudios de diversidad que se han realizado en los bovinos criollos en el país.

El Instituto Nacional de Investigación y Extensión Agraria (INIEA), tiene la misión de conservar y proteger los recursos genéticos en condiciones *in-situ* y *ex-situ*. Desde el año 2003 se vienen desarrollando actividades relacionadas con la conservación, caracterización e identificación de caracteres utilitarios de los recursos zoogenéticos (Rivas *et al*., 2004), con énfasis en especies domésticas como los bovinos criollos, habiéndose identificado poblaciones en las regiones de Ancash, Ayacucho, Apurímac, Junín y Puno (sierra norte, centro y sur del Perú). En colaboración con las Comunidades Campesinas, se viene desarrollando actividades de caracterización morfométrica, productiva (parámetros lecheros), bioquímica y molecular (empleando marcadores microsatélites y RFLPs), a fin de establecer la existencia de uno o más morfotipos definidos que podrían constituir la base de nuevas razas bovinas en el Perú.

Materiales y Métodos

Trabajo de campo

1. Identificación de comunidades dedicadas a la crianza de bovinos criollos. Se están evaluando los bovinos que se manejan en 12 comunidades campesinas en las regiones de Ancash, Ayacucho, Apurímac, Junín y Puno (151 familias campesinas); se abarca la sierra norte, centro y sur del Perú (Figura 1). También se llevan a cabo talleres participativos con los criadores sobre la importancia de la conservación del bovino criollo.
2. Muestreo de sangre - Se han realizado tomas de muestras de sangre entera de 529 bovinos criollos de las diferentes Regiones del Perú, para los trabajos de caracterización. Cada animal ha sido identificado con un código que le ha sido colocado en un arete para poder localizarlo con facilidad en cualquier momento.
3. Mediciones morfométricas - Se ha elaborado una ficha morfométrica (Figura 2) tomando como referencia los parámetros de caracterización morfométrica descritos en otras especies domésticas (Folch y Jordana, 1997; Rodríguez, *et al*., 2001; Méndez Mendoza, *et al*., 2002), la cual además incluye un registro fotográfico de cada animal así como información del propietario y la ubicación geográfica del lugar (con información de GPS). Se han registrado las mediciones corporales de la región cefálica, tronco y extremidades (alzadas, longitudes, diámetros, perímetros, etc.), empleando un bastón zoométrico y una cinta métrica extensible. A partir de los valores de la ficha morfométrica se estimarán 12 índices corporales, los que permitirán determinar la variabilidad fenotípica de los bovinos criollos de las diferentes comunidades y el establecimiento de un patrón fenotípico de caracterización.
4. Control de la producción lechera - Regularmente se monitorea la producción lechera individual y del rebaño registrándose información sobre producción de vacas con genotipo conocido de proteínas lácteas conocido. Asimismo, se toma una muestra para realizar el análisis bioquímico de la leche (contenido de sólidos totales, grasa y proteínas etc.); para tener una visión detallada del manejo productivo individual y del rebaño y relacionarlo con el genotipo de proteínas lácteas en los individuos.

Trabajo de laboratorio

1. Extracción de ADN - El ADN es extraído a partir de muestras de sangre entera, para ello se aislan los linfocitos por lavados sucesivos con Buffer Tris EDTA 20:5 v/v, pH 8,0; la extracción se realiza empleando el protocolo de Sambrook y Russell (2001) modificado en el Laboratorio de Biología Molecular del INIEA.
2. Caracterización molecular de morfotipos candidatos a raza - La caracterización molecular de morfotipos de bovinos criollos se viene desarrollando por análisis de polimorfismos de microsatélites de ADN amplificado (PCR-SSR); se están empleando 10 iniciadores para bovinos recomendados por la Internacional Society of Animal Genetics y FAO (FAO, 2004; tabla 1). Las condiciones de PCR estandarizadas para los iniciadores son variables, en algunos casos se realizan amplificaciones múltiplex.
3. Genotipado de proteínas lácteas - La identificación de genes de proteínas lácteas se realiza por análisis de fragmentos de restricción de ADN amplificado (PCR-RFLP). Estos análisis están basados en los protocolos descritos por Poli y Medrano (1997) utilizando los primers JK5 y JK3 y la endonucleasa de restricción Hinf I para el diagnóstico de los alelos A y B de las kappa caseínas; y los primers BLGP3 , BLGP4 y la endonucleasa de restricción Hae III para los alelos A y B de beta lactoglobulinas.

Resultados y Discusión

La domesticación de animales de granja se inició hace 12 000 años cuando el hombre comenzó a mantener animales como fuerza de trabajo, alimento, fibra y otros usos pecuarios (FAO, 1998). Antes de la domesticación actuaba solo la selección natural; posteriormente a la acción consciente y directa del hombre a través de una reproducción dirigida en base a una selección fenotípica sobre determinados caracteres morfológicos y productivos, se fueron singularizando diversos

Tabla 1. Iniciadores seleccionados para las actividades de caracterización molecular mediante microsatélites en los bovinos criollos.

Iniciadores	Secuencia (5´-3´)
ETH225 (D9S1)	GATCACCTTGCCACTATTTCCT ACATGACAGCCAGCTGCTACT
ETH152 (D5S1)	TACTCGTAGGGCAGGCTGCCTG GAGACCTCAGGGTTGGTGATCAG
ILSTS005 (D10S25)	GGAAGCAATGAAATCTATAGCC TGTTCTGTGAGTTTGTAAGC
ILSTS006 (D7S8)	TGTCTGTATTTCTGCTGTGG ACACGGAAGCGATCTAAACG
HEL5 (D21S15)	GCAGGATCACTTGTTAGGGA AGACGTTAGTGTACATTAAC
HEL1 (D15S10)	CAACAGCTATTTAACAAGGA AGGCTACAGTCCATGGGATT
HEL13 (D11S15)	TAAGGACTTGAGATAAGGAG CCATCTACCTCCATCTTAAC
BM2113(D2S26)	GCTGCCTTCTACCAAATACCC CTTAGACAACAGGGGTTTGG
BM1818 (D23S21)	AGCTGGGAATATAACCAAAGG AGTGCTTTCAAGGTCCATGC
BM1824 (D1S34)	GAGCAAGGTGTTTTTCCAATC CATTCTCCAACTGCTTCCTTG

grupos de cada especie en cada región, conduciendo a la aparición y consolidación de razas concretas (Sierra, 2001).

Actualmente la mayor parte de la producción pecuaria deriva solo de 14 especies que abarcan unas 5 000 razas. Muchas razas de animales domésticos están en peligro de desaparición, siendo la causa principal la erosión genética producida por la introducción de germoplasma exótico, así como las pobres políticas agropecuarias, restricción al desarrollo de sólo unas cuantas razas, cambios en los requerimientos de mercado, degradación de ecosistemas, desastres naturales, entre otras causas (FAO, 1998).

En el caso del bovino criollo peruano, éste proviene del cruzamiento indiscriminado de razas de bovinos introducidas desde el segundo viaje de Colon a América. Desde hace 500 años estos animales vienen experimentando un proceso de adaptación a las condiciones medioambientales principalmente de la sierra del Perú. Su producción se localiza en valles interandinos y puna alto andina, donde razas mejoradas no pueden desarrollarse. Su crianza está arraigada en la mayoría de comunidades campesinas y pequeños productores que lo utilizan no sólo como animal productivo (carne, leche y fuerza de trabajo) sino como mecanismo de ahorro. No obstante, a pesar de esfuerzos aislados, poco se ha hecho para caracterizar genética y productivamente a las poblaciones de bovinos criollos del Perú. No contamos con razas caracterizadas de bovinos criollos, a diferencia de nuestros vecinos de los otros países sudamericanos como Colombia, Bolivia y Brasil, entre otros. Asimismo, persiste la idea equivocada de que el mejoramiento del bovino criollo debe ser realizado a través del cruzamiento con razas exóticas y no a través de la selección y mejora de los criollos.

Las actividades de caracterización del bovino criollo en el INIEA se iniciaron en el 2003 y culminarán en 2007; estos trabajos son realizados por el área de recursos genéticos de la institución (Sub Dirección Nacional de Recursos Genéticos y Biotecnología). Para finales del quinquenio se espera conseguir al menos 3 poblaciones de bovinos criollos con variabilidad conocida para los genes de kappa-caseínas y beta lactoglobulinas, y al menos 2 ecotipos de bovinos criollos candidatos a razas. La caracterización deberá incluir el fenotipo (marcadores morfológicos, bioquímicos y registros de producción) y genotipo (marcadores moleculares).

El conocimiento que se está generando a través de estas actividades en su conjunto, benefician a las familias campesinas asociadas a la crianza del bovino criollo en las regiones de Junín, Ancash, Huancavelica, Ayacucho, Apurímac y Puno. En la figura 1 se muestra la ubicación geográfica de estas comunidades campesinas.

En la tabla 2 se muestra la relación de comunidades campesinas (CC) de la Regiones de Ancash, Ayacucho, Junín y Puno, así como los Centros de Investigación Pecuaria (CIPs) y las Estaciones Experimentales Agrarias (EEAs) del Instituto Nacional de Investigación y Extensión Agraria (INIEA), indicando el lugar, el número de bovinos criollos identificados y las actividades de investigación enmarcadas en la caracterización de este recurso zoogenético.

Los criadores de bovinos criollos de estas comunidades están tomando conciencia de la valoración de sus morfotipos locales, así como de la importancia que tiene la identificación de cualidades deseables en estos animales, para su aplicación a corto plazo en la obtención de sistemas

Figura 1. Ubicación geográfica (medida con GPS) de las regiones donde se han identificado bovinos criollos.

Tabla 2. Relación de comunidades campesinas e instituciones con las que se está desarrollando las actividades de conservación y caracterización del bovino criollo peruano. CCs = Comunidades campesinas; CIP = Centro de Investigación Pecuaria; EEAs = Estaciones Experimentales Agrarias (EEAs) del Instituto Nacional de Investigación y Extensión Agraria (INIEA).

Comunidad campesina y/o Institución	Lugar - Región	Numero bovinos criollos identificados	Actividad de investigación	
			Genotipado de proteínas lácteas por PCR - RFLP	Caracterización molecular por PCR- SSR
EEA Santa Ana	Huancayo, Junín	17		X
CC Panti	Huancayo, Junín	30		X
CC Occoro	Huancayo, Junín	30		X
CC Huasapa	Huancayo, Junín	36		X
CIP Chuquimbambilla, Universidad Nacional del Altiplano	Ayaviri, Puno	53		X
CC Lampa Grande	Chuchito, Puno	22	X	X
CC Huacani	Chucuito, Puno	18	X	X
EEA Illpa	Puno, Puno	15	X	X
CC Huashcao	Yungay, Ancash	22	X	
CC Ticllos	Bolognesi, Ancash	31	X	
CC Mesapampa	Bolognesi, Ancash	29	X	
CC Pampa de Lampas	Bolognesi, Ancash	27	X	
CC Qochapunco	Huamanga, Ayacucho	99	X	X
CC Santa Elena	Andahuaylas-Apurímac	50	X	X
CC Ampi	Andahuaylas-Apurímac	50	X	X
Total de bovinos criollos identificados		529		

de producción sostenibles a diferencia de las razas exóticas que requieren una mayor cantidad de insumos para lograr su nivel óptimo de producción, llegando a ser muy frágiles en las condiciones donde los criollos se desempeñan adecuadamente.

En los últimos 100 años se ha producido un aumento en la tasa de extinción de razas y variedades, representando una dramática perdida de variabilidad genética dentro del pool global de animales domésticos. Los cambios en las preferencias por ciertas razas de bovinos, se deben generalmente a influencias socio-económicas, que surgen debido a una pobre política agropecuaria, que lo que hace es promover la fijación rápida de lo que no es sostenible a largo plazo o cambios según los requerimientos existentes en el mercado de productos (FAO, 1998).

Actualmente contamos con 302 registros de bovinos criollos con medidas morfométricas. Cada registro incluye los datos del propietario, localización geográfica (unidades GPS), un conjunto de medidas zoométricas (cabeza, tronco y extremidades) y el registro fotográfico del animal (Figura 2). Los datos morfométricos representan los caracteres fenotípicos que se convertirán una vez finalizado el trabajo en importantes descriptores de los morfotipos, con los que se obtendrán índices corporales característicos. En la figura 3 se muestra la variabilidad fenotípica de los bovinos criollos del Perú.

La descripción de morfotipos en las comunidades de las diferentes regiones constituye un paso fundamental para implementar mecanismos de propiedad intelectual, como la "Denominación de Origen". En España las "Denominaciones de Origen" y las "Indicaciones Geográficas" forman parte del sistema utilizado para el reconocimiento de una calidad superior de

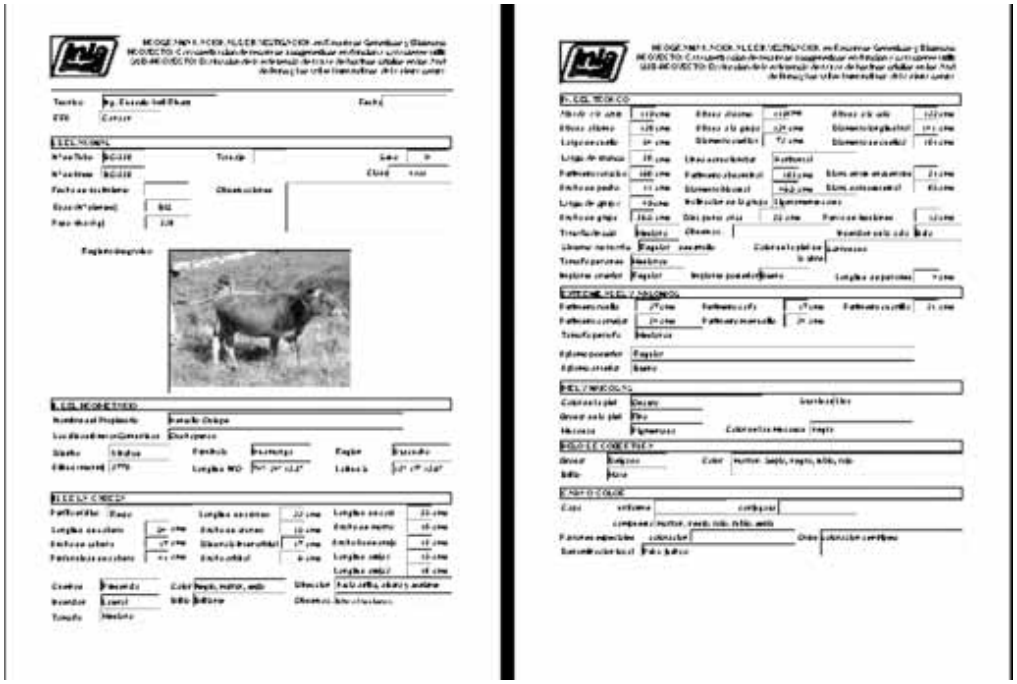

Figura 2. Ficha morfométrica de bovinos criollos conteniendo el registro fotográfico, datos del propietario y medidas morfométricas de la cabeza, tronco y extremidades.

un producto agrícola o un producto alimenticio (por ejemplo, el vino Rioja, jamón serrano Pata Negra, queso Manchego, etc.) originario de dicha región, que surge como consecuencia de características propias y diferenciales, debidas al medio geográfico en el que se producen las materias primas, se elaboran los productos, y a la influencia del factor humano que participa en las mismas.

En cuanto al estudio e identificación de genotipos de proteínas lácteas, se sabe que las caseínas y proteínas del suero presentan diversas variantes genéticas que son determinantes en las propiedades fisicoquímicas de la leche (López y Vásquez, 2004); es así que en otras razas bovinas se ha reportado que los genotipos BB de kappa caseínas se asocian con una capacidad lechera superior debido a que la leche de vacas que tienen este alelo producen mezclas de menor tamaño, en las cuales se retienen mas sólidos en el momento de la coagulación para la producción de quesos, originando coágulos que contienen mas grasa y menos agua y por tanto son mas firmes y adecuados para un rendimiento quesero superior (Sherbon *et al*., 1967; Ng-Kwai-Hang *et al*., 1984). En este sentido, el conocimiento de genotipos de proteínas lácteas en los bovinos criollos podrá aplicarse en las comunidades campesinas con fines de selección y mejora para el carácter rendimiento quesero.

Todas estas particularidades junto a la necesidad de mantener y valorar nuestros recursos genéticos animales para su aprovechamiento productivo y como reserva de genes con vistas al futuro, justifican su conservación y caracterización. De esta manera, estos marcadores moleculares para proteínas lácteas constituyen una herramienta para esa diferenciación racial. Así, consideramos que el estudio del bovino criollo peruano constituye un aporte, mediante la caracterización genética e identificación de caracteres útiles, a la revaloración y al fortalecimiento de la conservación *in-situ* y *ex-situ* de nuestra diversidad genética animal, la cual realizan principalmente las comunidades campesinas y algunas instituciones públicas y privadas a nivel nacional.

En la tabla 3 se muestran resultados preliminares de las frecuencias genotípicas y alélicas encontradas y esperadas para las poblaciones de bovinos criollos de las comunidades de Huaschao y Ticllos (Región Ancash). Al analizar los genotipos entre poblaciones se observa que hay presencia del alelo B de kappa caseínas, reportado como favorable para el rendimiento quesero. Por tanto, estas poblaciones cuentan potencialmente con base genética como para hacer selección y eventualmente mejoramiento. Se continuará con el genotipado de proteínas lácteas en otras comunidades y se comenzará a implementar el control de producción lechera, el registro y control de parentesco, así como la determinación de

Criollo callejón negro o "yana pillco" de la comunidad campesina de Panti – Pariahuanca Región Junín.

Criollo negro o "yana" de la comunidad campesina de Occoro – Pariahuanca Región Junín.

Criollo rubio colorado o "puka" de la comunidad campesina de Qochapunco – Vinchos Región Ayacucho.

Criollo moro de la comunidad campesina de Ticllos – Bolognesi Región Ancash.

Criollo pinto de la comunidad campesina de Huacani – Chuchito Región Puno.

Criollo moro de la comunidad campesina de Ticllos – Bolognesi Región Ancash.

Figura 3. Variabilidad de morfotipos de bovinos criollos de la región Ancash, Ayacucho, Apurímac, Junín y Puno.

Criollo rubio colorado o "puka" comunidad campesina de Ampi – Pariahuanca Región Junín.

Criollo callejón rojo o "puka pillco" de la comunidad campesina de Ampi – Pacucha Región Apurímac.

Criollo barroso de la comunidad campesina de Ticllos – Bolognesi, Región Ancash.

Figura 3. Sigue desde la pagina anterior.

Tabla 3. Frecuencias genotípicas y alélicas del gen κ-caseína observadas y esperadas en bovinos criollos de las comunidades de Huashcao y Ticllos (Región Ancash).

	Huashcao				Ticllos			
	Observado		Esperado		Observado		Esperado	
Genotipo	No.	%	N°	%	No.	%	No.	%
AA	11	0.50	9	0.41	7	0.23	8	0.25
AB	6	0.27	10	0.46	17	0.55	16	0.50
BB	5	0.23 (ns)	3	0.13	7	0.23(ns)	8	0.25
Alelos		%				%		
A		0.64 (ns)				0.50 (ns)		
B		0.36 (ns)				0.50 (ns)		
Heterocigocidad		27.27%				54.83%		

relaciones de parentesco en los morfotipos de bovinos criollos.

Conclusiones

Los bovinos criollos en el Perú, denominados "*chuscos*", cumplen un rol importante en la vida de las comunidades campesinas; su adaptación a diversos ecosistemas, los hace de gran valor potencial como fuente de genes útiles y servicios ambientales. A pesar de ello, son considerados como un recurso marginal que debe ser sustituido por especies y razas exóticas mejoradas. La política nacional de desarrollo ganadero propone el incremento de la productividad a partir de la importación de reproductores con una alta tasa productiva pero con poca o ninguna adaptación a las condiciones extremas de los Andes del Perú. Ello estaría provocando procesos de erosión genética debido al reemplazo de bovinos criollos por razas exóticas que responden a sistemas de producción con una elevada relación consumo/producción. Como consecuencia, se deja de aprovechar la condición de raza primaria del bovino criollo peruano, perdiéndose el potencial que significa las adaptaciones locales y su facilidad para aprovechar mejor los recursos de su difícil ambiente. En el marco de las actividades de caracterización de las poblaciones de bovinos criollos del Perú, se ha identificado la presencia del alelos de proteínas lácteas favorables para el rendimiento quesero, lo que los hace potencialmente valiosos por contar con base genética para hacer selección y eventualmente mejoramiento hacia un mayor rendimiento quesero; asimismo, se está trabajando en la caracterización molecular de los diferentes morfotipos con microsatélites y en la caracterización morfométrica.

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Caractérisation phénotypique des bovins à viande (*Bos taurus* et *Bos indicus*) au centre (Bouaké) et au nord (Korhogo) de la Côte d'Ivoire

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Résumé

Une enquête a été menée dans les régions de Bouaké et de Korhogo pour inventorier et caractériser les différents types de bovins à viande. Des mesures barymétriques ont été enregistrées sur 511 animaux à Bouaké et 929 à Korhogo pour lesquels les éleveurs ont été invités à indiquer le nom du type phénotypique. L'inventaire des élevages a permis d'identifier 5 types phénotypiques de bovins que sont le N'Dama, le Baoulé, le Zébu, le Méré et le "*Métis*". Les descripteurs qui permettent d'identifier au mieux ces différents types de bovins sont la présence/absence de bosse, la couleur de la robe, le périmètre thoracique et la hauteur au garrot. Malgré le métissage qui s'exerce sur elles, les races taurines (N'Dama et Baoulé) présentent des populations homogènes et stables. Le Méré présente une population homogène dans la région de Korhogo et semble être un type phénotypique bien fixé avec 83% d'animaux bien classés. Le pourcentage moyen d'animaux bien classés dans les régions de Bouaké et Korhogo est respectivement de 79 et 68%; ce qui dénote une très bonne connaissance des animaux par les éleveurs. Les caractères déterminants identifiés à partir de cette analyse peuvent servir à définir les standards des races concernées.

Summary

A survey was conducted in the Bouaké and Korhogo regions in order to take an inventory of and characterize the different types of meat cattle raised in the regions. Barymetric data was collected from 511 animals in Bouaké and 929 in Korhogo and the cattle owners were invited to indicate the name of each of the phenotypes identified. Five phenotypic types, including N'Dama, Baoulé, Zebu, Méré and Métis were identified. Discriminant analysis revealed that the presence or absence of a hump, coat colour, heart gird and height at withers were the most important descriptors which differentiated the five phenotypic types. Despite the impact of inbreeding exerted upon them, the N'Dama and Baoulé breeds presented homogenous and stable populations. The Méré breed presents a homogenous population in the region of Korhogo and seems to be a well established phenotypic type with 83.8% of animals well classified in that region. The average percentage of well classified animals in Bouaké and Korhogo regions were 79 and 68%, respectively. This result shows that cattle owners identification of their animals was quite accurate. The identified determinant characters stemming from this analysis can be used to define breed standards for the breeds concerned.

Mots clés*: Bovins à viande, Caractérisation phénotypique, Variables discriminantes, Classement des animaux.*

Introduction

La Côte d'Ivoire, pays plutôt de tradition agricole que pastorale, compte dans son patrimoine génétique animal trois races locales de taurins: la race N'Dama, la race Baoulé et la race Lagune. Ces races, très bien adaptées aux conditions climatiques tropicales locales, sont par ailleurs résistantes aux nombreuses parasitoses, et trypanotolérantes (Domingo, 1976). Malheureusement leur utilité vis-à-vis de l'homme et leurs contributions à l'agriculture durable sont encore mal reconnues. Ceci a pour conséquence la menace voire l'extinction des ressources génétiques animales. La conservation de la diversité génétique des animaux domestiques a pour fondement l'identification et la caractérisation des ressources génétiques comme l'atteste la ligne des recommandations du Programme Action 21 de la Convention sur la biodiversité (FAO/UNEP, 2000).

L'ethnologie, l'écologie et l'étude de la répartition géographique des races trypanotolérantes de Côte d'Ivoire a fait l'objet de nombreux écrits (Doutressoule, 1949; Tidori *et al*., 1975; CIPEA, 1979; Landais, 1983; Yapi-Gnaoré *et al*., 1996). La descriptions de ces races est souvent limitée et n'a pas la précision de celle des races des régions tempérées où la sélection a uniformisé les caractéristiques esthétiques et économiques (Quéval et Petit, 1982). En effet, la recherche par les éleveurs ivoiriens d'animaux de grand format et l'introduction en Côte d'Ivoire sous trypanocide de Zébus transhumants du Sahel chassés par la sécheresse, ont entraîné des opérations de métissage intenses et anarchiques des races locales. Les races locales impliquées dans ce métissage sont principalement les races Baoulé et N'Dama. Pour la race Baoulé, Landais (1983) estimait à plus de 50% le nombre de reproductrices métissées.

Par ailleurs plusieurs croisements sont issus de l'utilisation de races exotiques avec la N'Dama, notamment la Fleckvieh, l'Abondance et la Jersiais. Ces croisements sont généralement faits par les paysans situés à proximité des grandes villes. Ils répondent aux besoins particuliers d'approvisionnement en lait de ces villes. Ainsi la multiplicité des races bovines rencontrées dans les fermes est-elle liée à la diversité des modèles d'élevage et de leurs objectifs (Planchenault et Boutonnet, 1997). Par conséquent les taurins locaux, mieux adaptés aux conditions locales d'élevage que les Zébus et les races exotiques, se trouvent menacés. La présente étude se propose:

1. D'inventorier les différents types de bovins à viande élevés dans le centre et le nord de la Côte d'Ivoire, notamment dans les régions de Bouaké et de Korhogo.
2. De caractériser ces types de bovins et de mettre en évidence les caractères discriminants à partir du savoir des éleveurs.

Matériel et Méthodes

Echantillonnage

L'étude a porté sur 1 440 animaux mâles et femelles dont 511 échantillonés à Bouaké et 929 à Korhogo au cours des années 2001 et 2002. Ces animaux proviennent de grandes exploitations privées et des élevages ruraux (9 à Bouaké et 28 à Korhogo) situés dans un rayon de 35 km autour de ces deux villes. L'enquête réalisée sur les fermes a porté sur l'identification de la ferme, sa localisation, les types de bovins élevés, l'origine des animaux, leur utilisation et leurs effectifs. Le choix des fermes dans lesquelles les animaux ont été caractérisés s'est fait, essentiellement, sur la base de la disponibilité des éleveurs et de la présence, dans la ferme, de parcs munis de couloirs de contention. Les éleveurs ont été invités à indiquer le nom attribué à chaque type phénotypique rencontré dans leurs élevages.

Descripteurs phénotypiques

Une fois le type phénotypique d'un animal a été indiqué par l'éleveur, les enquêteurs décrivent le phénotype de l'animal. Les éléments phénotypiques pris en compte sont les descripteurs définis par la FAO (1986). Ces descripteurs concernent: la couleur (robe, peau, tête, museau, corne, sabots, visage); les caractères linéaires (hauteur au garrot, longueur [corne, tête, oreille, corps, tronc], largeur de la tête, circonférence à la base de la corne, espace intercorné, périmètre thoracique); la forme (corne, bosse, tête, oreille, profil de la tête); le sexe; le poids et l'âge.

Le poids a été estimé à l'aide d'un ruban barymétrique, sur la base de sa corrélation avec le périmètre thoracique. L'âge des animaux a été calculé à partir de la date de naissance ou estimé à partir de la dentition.

Analyse statistique

Les descripteurs phénotypiques ont été analysés par la méthode de l'analyse discriminante du logiciel SPSS 7.5, afin de déterminer les descripteurs permettant de décrire au mieux les types phénotypiques. Les caractères «poids» et «âge» ont été introduits dans l'analyse comme des covariables pour pouvoir corriger leur effet sur les caractères linéaires.

Résultats

Types phénotypiques rencontrés

L'enquête dans les fermes des régions de Bouaké et de Korhogo, a permis d'identifier 5 types phénotypiques de bovins que sont le N'Dama, le Baoulé, le Zébu, le Méré et le Métis (Tableau 1). La dénomination "*Métis*" a été donné à tous les animaux reconnus comme des croisés par les éleveurs, mais dont les races parentales sont inconnues.

Tableau 1. Effectif des types phénotypiques de bovins à viande identifiés dans les régions de Bouaké et de Korhogo.

	Bouaké		Korhogo		
Types phénotypiques	Mâles	Femelles	Mâles	Femelles	Total
N'Dama	20	166	7	40	233
Baoulé	39	110	37	198	384
Zébu	26	89	59	122	296
Métis	2	27	28	136	193
Méré	1	31	71	231	334
Total	511		929		1 440

Détermination des variables discriminantes

La détermination des variables discriminantes a été effectuée à partir de 4 axes dont le principal (F_1) décrit 61,4% de la variabilité totale dans la région de Bouaké et 86,6% dans la région de Korhogo. Le deuxième axe important (F_2) décrit 35,5% de la variabilité totale dans la région de Bouaké et 7,1% dans la région de Korhogo. Ces deux axes F_1 et F_2 décrivant à eux seuls 96,9% de la variabilité totale dans la région de Bouaké et 95,7% dans la région de Korhogo, suffisent à classer les 5 types phénotypiques.

Dans la région de Bouaké, sur 20 variables introduites dans l'analyse, seules 9 ont été jugées comme celles pouvant distinguer au mieux les 5 types phénotypiques. Ce sont la couleur de la peau, la couleur de la robe, la couleur des sabots, la forme des cornes, la hauteur au garrot, la longueur de la corne, la longueur de la tête, le périmètre thoracique, la présence de tâches sur la robe (Tableau 2). L'axe F_1 est essentiellement défini par le caractère couleur de la peau (PO) avec une forte contribution de 0,939. L'axe F_2 est défini par la hauteur au garrot, variable la plus discriminante pour cet axe avec une contribution de 1,309. Au regard des coefficients affectés aux variables discriminantes, l'axe F_1 se définit comme l'axe des couleurs et F_2 comme l'axe des caractères linéaires.

Dans la région de Korhogo, ce sont 26 variables qui ont été introduites dans l'analyse. Onze (11) d'entre elles ont été identifiées comme celles permettant de mieux caractériser les populations bovines. Ce sont la présence/absence de bosse, la couleur de la peau, la couleur de la robe, la hauteur au garrot, la longueur du corps, la taille de la bosse, la couleur du museau, la forme des cornes, l'orientation des cornes, la longueur des oreilles et le profile de la tête. L'axe F_1 est défini par le caractère présence/absence de bosse (BOSS) avec une contribution de 0,948. La couleur de la peau (PO), se présente comme la variable la plus importante de l'axe F_2 avec une contribution de 0,542.

Classement des animaux

L'analyse discriminante a révélé que les bovins de ces deux régions sont bien classés en moyenne à 79% pour Bouaké et 68% pour Korhogo selon les descriptions fournies par les éleveurs. Les races N'Dama et Baoulé constituent des populations homogènes dans les deux régions. L'échantillon de la race N'Dama renferme 95,7% d'animaux correctement classés à Bouaké et 80,9% à Korhogo (Tableaux 3 et 4). En ce qui concerne Le Zébu, le pourcentage d'animaux correctement classés est de 75.7% pour la région de Bouaké et de 51,4% pour la région de Korhogo. Quant au type Méré, alors qu'il semble très instable dans la région de Bouaké (12,5% d'animaux correctement classés), il présente une population homogène dans la région de Korhogo (83,8% d'animaux correctement classés). Le type Métis constitué de 31,0% d'animaux correctement classés à Bouaké et de 18,3% à Korhogo ne peut pas être considéré comme une race de bovins dans les deux régions. Les éleveurs englobent sous le vocal "*Métis*" tous les produits de croisements dont ils ignorent les races parentales. Le Métis se caractérise par une grande variabilité phénotypique. Son phénotype se trouve dispersé au niveau des Zébu, N'Dama, Baoulé et Méré (Figure 1a et 1b). Les figures 1a et 1b indiquent la distribution des cinq types phénotypiques en fonction des axes F1 et F2 dans les deux régions. A Bouaké les Zébu, Méré et Métis forment pratiquement un même groupe; tandis qu'à Korhogo, les Méré se détachent des Zébus et Métis.

Tableau 2. Contribution des variables discriminantes aux axes F_1 et F_2 pour les régions de Bouaké et de Korhogo.

	Bouaké										
	LgT	PO	SABO	Forco	HG	LgC	PT	ROBE	Tache	Age	
F1	0.195	0.939	-0.243	0.200	0.269	-0.492	-0.242	0.211	0.183	0.065	
F2	0.283	0.055	-0.002	-0.436	1.309	0.433	-0.644	0.014	0.082	-0.574	
	Korhogo										
	BOSS	PO	ORC	Forco	HG	MUSO	PFIL	ROBE	LgOr	T.BOS	LgA
F1	0.948	0.007	0.104	0.065	-0.031	0.045	-0.007	-0.021	0.106	-0.098	-0.130
F2	-0.320	0.542	0.289	-0.168	-0.374	0.268	-0.081	0.423	-0.109	-0.237	-0.036

PO = Couleur de la peau; ROBE = Couleur de la robe; SABO = Couleur des sabots; Forco = Forme des cornes; HG = Hauteur au garrot; LgC = Longueur de la corne; LgT = Longueur de la tête; PT = Périmètre thoracique; Tâche = Présence/absence de Tâche sur la robe; BOSS = Présence/Absence de bosse; LgOr = Longueur de l'oreille; ORC = Orientation des cornes; MUSO = Couleur du museau; PFIL = Profil de la tête; T.BOS = Taille de la bosse; LgA = Longueur du corps.

Tableau 3. Pourcentage d'animaux correctement ou incorrectement classés (Région de Bouaké).

Race	Groupes prédits						Nombre d'animaux
	N'Dama	Baoulé	Zébu	Métis	Méré	Total	
N'Dama	**95.7**	2.2	1.6	0	0.5	100%	186
Baoulé	4.7	**85.2**	6.7	2.7	0.7	100%	149
Zébu	11.3	4.3	**75.7**	7.8	0.9	100%	115
Métis	10.3	24.1	34.5	**31.0**	0	100%	29
Méré	21.9	31.3	31.3	3.1	**12.5**	100%	32

NB: Le pourcentage d'animaux correctement classés se lit au niveau de la première diagonale.

Tableau 4. Pourcentage d'animaux correctement ou incorrectement classés (Région de Korhogo).

Race	Groupes prédits						Nombre d'animaux
	N'Dama	Baoulé	Zébu	Métis	Méré	Total	
N'Dama	**80.9**	19.1	0.0	0.0	0.0	100%	47
Baoulé	4.7	**95.3**	0.0	0.0	0.0	100%	235
Zébu	0.0	0.0	**51.4**	9.4	39.2	100%	181
Métis	4.9	17.1	14.6	**18.3**	48.2	100%	164
Méré	0.0	0.0	10.3	6.0	**83.8**	100%	302

NB: Le pourcentage d'animaux correctement classés se lit au niveau de la première diagonale.

Discussion

Description phénotypique des types de bovins suivant les caractères déterminants

Les résultats montrent que les cinq (5) types de bovins à viande peuvent être identifiés avec les descriptions phénotypiques suivantes.

N'dama

Le bovin N'Dama présente en général une robe fauve ou fauve-pie (Figure 2). C'est un animal de taille moyenne dont la hauteur au garrot a varié de 108 à 117 cm pour des animaux d'âge compris entre 4 et 8 ans. Ces mensurations sont comparables à celles obtenues par Coulomb (1976) qui a évalué la moyenne de la hauteur au garrot, à l'âge de 4 ans, à 116,4 cm pour le mâle et 113,6 cm pour les femelles. Par contre, les mensurations obtenues par Choquel (1969) sont nettement inférieures; 104 cm pour la femelle et 110 cm pour le mâle. Le périmètre thoracique varie de 140 à 170 cm. La race N'Dama présente une tête au profil droit avec un museau rose ou fauve. Ses cornes sont portées en croissant ou en coupe chez les sujets mâles. Les femelles ont de longues cornes en lyre effilées aux extrémités. Cette forme a été déjà observée et décrite par plusieurs auteurs (Aillerie, 1926; Doutressoule, 1946; Coulomb, 1976; Landais, 1983).

Baoulé

Le bovin Baoulé présente une robe de couleur variable; blanche, noire, pie-noire, noire-pie, pie rouge, rouge-pie et quelques fois rouge noire (Figure 3). Yapi-Gnaoré *et al*. (1996) ont également noté cette variabilité de la couleur de la robe et ont estimé qu'elle ne pouvait être un élément de caractérisation de cette race. Le bovin Baoulé est un animal de petit format; la hauteur au garrot a varié de 92 à 113 cm et le périmètre thoracique de 129 à 161 cm pour des animaux de plus de 4 ans. Tidori *et al*. (1975) ont observé une taille variant de 95 à 110 cm et un périmètre thoracique qui variait entre 128,4 et 140 cm sur des bovins Baoulé au CRZ de Minankro (Bouaké). La race Baoulé présente une tête au profil droit, avec un museau noir ou blanc. Les cornes sont généralement en forme de croissant lunaire très ouvert vers le haut. L'on rencontre quelques fois des bovins Baoulé avec des cornes dirigées vers le bas. Chez les mâles, les cornes forment un '' U '' très évasé s'orientant latéralement.

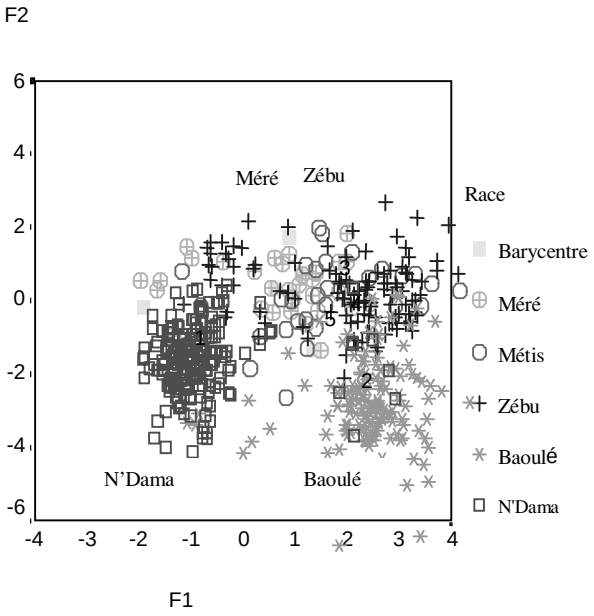


Figure 1a

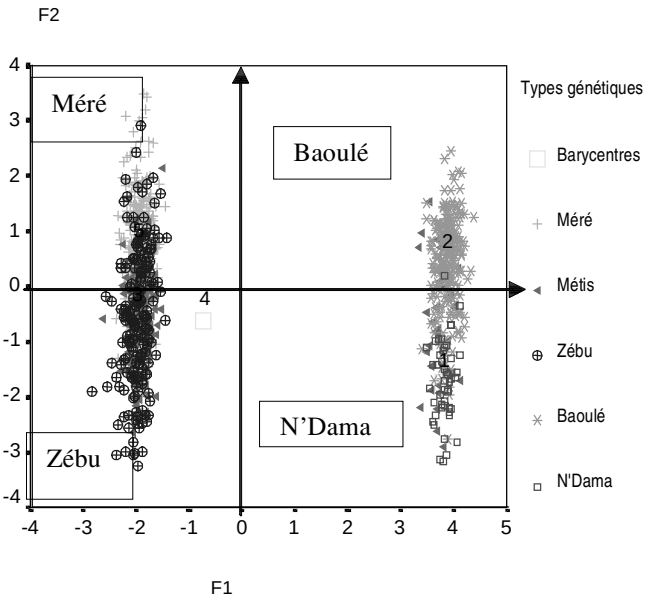


Figure 1b

Figure 1. Répartition des animaux dans le plan principal F1 - F2.
a) Région de Bouaké;
b) Région de Korhogo.

En général, les cornes en croissant sont orientées vers l'avant.

Zébu

Le nom Zébu est attribué de façon générique aux bovins à bosse (Figure 4). La couleur de la robe du bovin Zébu est très variable; une multitude de couleur a été observé allant du blanc au noir en passant par toutes les nuances de fauve et de noir. C'est un animal haut sur pattes; la hauteur au garrot variait de 118 à 130 cm pour des animaux de plus de 4 ans. Le périmètre thoracique variait de 143 à 172 cm. La tête est longue et fine avec un profil droit. Mais l'on rencontre des animaux au chanfrein long et légèrement convexe. Le museau est généralement noir, blanc ou fauve. La bosse a une taille très variable. La moyenne observée est de 17 cm. Chez les sujets mâles adultes, la bosse peut mesurer plus de 40 cm occupant tout le garrot et couchée latéralement. Cette caractéristique de la bosse est comparable à celle observée par IEMVT (1978) comme étant prononcée chez le taureau, et réduite chez la vache. Les cornes sont en forme de lyre haute, quelques fois spiralées. Elles sont orientées vers l'avant ou dressées vers le haut en forme de ''U'' très évasé.

Méré

Le Méré est en passe de devenir un type phénotypique fixé dans la région Nord de la Côte d'Ivoire. Il constitue une population homogène de bovins reconnue comme telle par les éleveurs de cette région. Il est le produit de croisements entre mâles Zébu et femelles Baoulé. Cependant, il est important de souligner que le Méré est un animal de taille moyenne (116±7,21 cm pour la hauteur au garrot; 155±13 cm pour la longueur de l'animal; 139±11 cm pour le périmètre thoracique). Sa robe est dominée par la fréquence de la couleur noire-pie. Il est caractérisé par une tête au profil droit, avec un museau noir, blanc ou fauve. La bosse du Méré (11±3 cm) est moins développée que pour les Zébu. Ses cornes, de taille moyenne (26 cm), sont courbées ou droites, formant généralement des croissants. Il est possible de rencontrer des cornes fixées latéralement ou des cornes en lyre courte. L'orientation de ces cornes est soit en avant, soit intérieure formant des coupes (Figure 5a, b).

a)

b)

Figure 2. Bovins N'Dama a) Taurillons et veaux; b) Taureau N'Dama.

Métis

Ces animaux sont le produit de croisements non spécifiques. Il n'est pas possible de les décrire avec précision à partir des caractères retenus. Cependant, il faut noter qu'à l'intérieur de ce groupe, on rencontre aussi bien des animaux à bosse que des animaux sans bosse. Le format est identique à celui du Méré. La robe de ces animaux présente toutes les nuances de couleur.

Classification des types phénotypiques

La race N'Dama avec un pourcentage de 95,7% d'animaux correctement classés dans la région de Bouaké et 80,9% dans la région de Korhogo, apparaît comme une race très homogène et stable. Ceci pourrait s'expliquer par le fait qu'elle est moins concernée par les métissages anarchiques. Les croisements dans lesquels elle est impliquée sont des croisements raisonnés, soit avec les Zébus, soit avec des races exotiques (Yapi-Gnaoré *et al*.,1996).

a)

b)

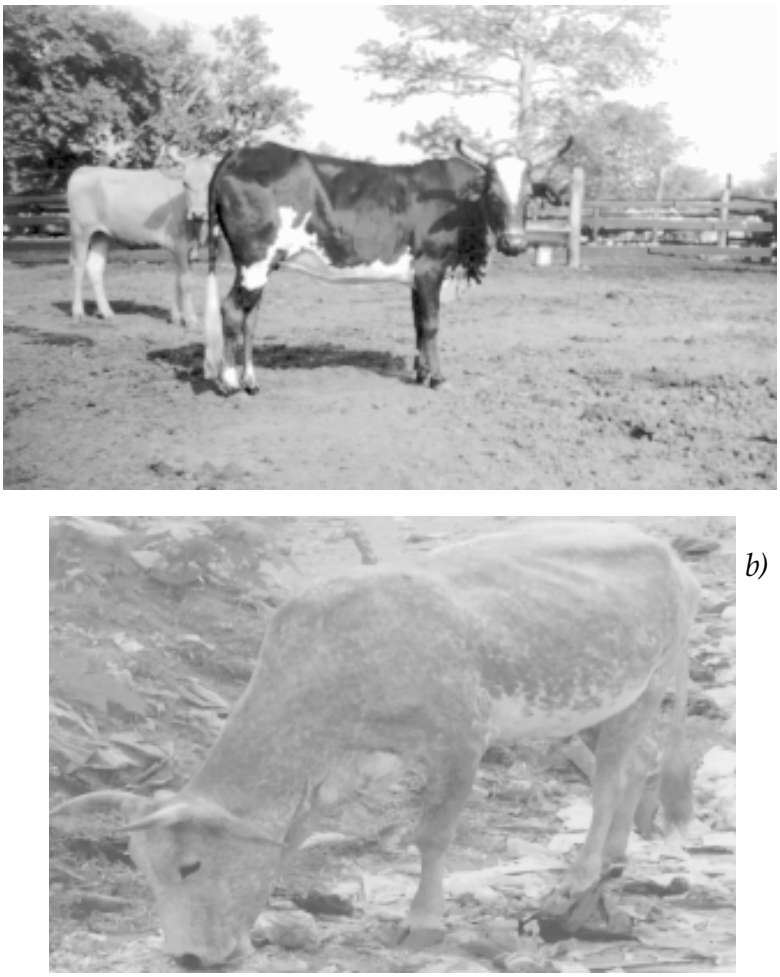
Figure 3. Bovin Baoulé a) Une femelle Baoulé à la robe pie-noire; b) Taureau Baoulé de la Station de Recherche en Elevage à Bouaké.

Les bovins N'Dama reclassés dans la race Baoulé (2,2% à Bouaké et 19,1% à Korhogo) et les 4,7% de bovins Baoulé reclassés dans la race N'Dama (aussi bien à Bouaké qu'à Korhogo) pourraient représenter des croisés N'Dama- Baoulé. En effet ces croisés sont souvent difficiles à distinguer des types purs; ce qui amène les éleveurs à les classer, selon leur phénotype, avec les types parentaux. Il faut également noter que les croisés N'Dama - Baoulé de première génération sont phénotypiquement plus proche du N'Dama qui marque fortement sa descendance (Landais, 1983).

La classification a révélé que malgré la pression de métissage qui s'exerce sur la race Baoulé, elle demeure homogène et stable; 95,3% d'animaux correctement classés dans la région de Korhogo et 852% dans la région de Bouaké. Les animaux Baoulé présentent des caractéristiques qui leur sont propres: petite taille, petit format, la robe pie-noire ou noire et des cornes courtes. Ces résultats sont similaires à ceux de Yapi-Gnaoré *et al*. (1996). Ceci confirme leur appartenance à la race taurine à courtes cornes.

Avec 75,7% et 51,4% d'animaux correctement classés à Bouaké et Korhogo, respectivement, le Zébu paraît moins stable que le N'Dama et le Baoulé. Cela s'explique aussi par les croisements anarchiques dans lesquels ce type de bovin est

Figure 4. Bovin Zébu (une femelle et son veau).



a)

b)

Figure 5. Méré dans une ferme villageoise a) et en zone urbaine b).

impliqué. En effet autant le petit format du bovin Baoulé l'expose aux croisements anarchiques avec les Zébus, autant la trypanosensibilité du bovin Zébu l'expose aux croisements avec les taurins locaux trypanotolérants. En effet, à Korhogo, 9,4% des Zébu sont supposés appartenir au type Métis et 39,2% au type Méré.

Dans la région de Bouaké, les élevages sont marqués par la présence constante de taureaux Zébu dans des troupeaux où on trouve à la fois des vaches Zébu, Baoulé et N'Dama. 90% des fermes visitées maintiennent toutes des géniteurs mâles Zébu. Ce constat a été fait également à Korhogo où les éleveurs s'adonnent au métissage de leurs troupeaux composés en majorité d'animaux Baoulé. La raison d'une telle pratique réside dans l'amélioration du format des Baoulé qui diffère significativement du Méré; produit du croisé Zébu-Baoulé. Ce produit est très utilisé comme animal de traction et donc très bien vendu (Landais, 1983). Selon les éleveurs, la vente du Méré rapporte deux fois plus que le Baoulé. Par conséquent, un métissage continu et non contrôlé peut mettre en danger la race locale Baoulé au profit des Méré. En effet, dans la région de Korhogo, le type Méré présente une population homogène avec 83,8% d'animaux correctement classés. La situation du Méré est différente dans la région de Bouaké, avec seulement 12,5% d'animaux correctement classés. Les animaux de ce type ont été reclassés au niveau du Zébu et du Baoulé dans les mêmes proportions (31,3%). Ceci constitue la preuve que le Méré est le produit du croisement entre le Zébu et le Baoulé. Cependant les 21,9% d'animaux classés chez le N'Dama laissent suggérer que dans ce cas précis le N'Dama n'est pas étranger à la constitution du type Méré ou que les éleveurs de Bouaké n'ont les mêmes définition du Méré. Ceci confirme aussi l'appellation de Méré souvent attribuée aux animaux issus de croisements N'Dama - Baoulé. En somme, le Méré n'est peut- être pas seulement issu du croisement Zébu - Baoulé, mais également du croisement N'Dama - Baoulé.

En ce qui concerne le Métis, l'hétérogénéité de la population de ce type s'explique aisément par la diversité des croisements dont sont issus les bovins Métis.

Conclusion

L'inventaire des élevages dans les régions de Bouaké et Korhogo a permis d'identifier 5 types de bovins à viande selon les éleveurs. Ces types sont le N'Dama, le Baoulé, le Zébu, le ''Métis'' et le Méré. L'analyse discriminante a révélé que les descripteurs qui permettent d'identifier au mieux ces différents types de bovins sont la présence/ absence de bosse, la couleur de la robe, le périmètre thoracique et la hauteur au garrot.

S'il est facile de distinguer phénotypiquement, de façon nette, un bovin Baoulé d'un bovin N'Dama ou d'un bovin Zébu, ce n'est pas le cas lorsqu'il s'agit de faire une distinction entre les Zébus, les Méré et les Métis. Le Méré, produit de croisements Zébu-Baoulé, présente une population très hétérogène à Bouaké. Par contre à Korhogo la population de Méré semble bien fixée et homogène. Les éleveurs semblent bien connaître les types phénotypiques élevés sur leurs fermes. Les informations fournies par chaque éleveur compilées et analysées ont montré qu'en moyenne 79% et 68% des animaux correspondaient aux types phénotypiques indiqués par les éleveurs, bien que la plupart des élevages se caractérisent par la présence de bovins Zébu, Baoulé, N'Dama, Méré et Métis dans le même troupeau. Il faut également noter l'émergence du phénotype Méré dans le cheptel bovin de la Côte d'Ivoire dont les caractéristiques sont bien connues par les éleveurs du nord du pays. Y-a-t-il besoin de s'inquiéter des conséquences du métissage opéré par les éleveurs sur la population de taurins ? Ou plutôt faut-il les impliquer dans la conservation des ressources génétiques animales dont ils semblent bien maîtriser l'utilisation? La caractérisation moléculaire de ces bovins à viande pourra indiquer avec précision le status des taurins en Côte d'Ivoire.

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On-farm characterization and present status of North Bengal Grey (NBG) cattle in Bangladesh

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Summary

North Bengal Grey (NBG) cattle are an important indigenous cattle genetic resource found mainly in the northern part of Bangladesh. The study was undertaken at Bogra Sadar, Shibgonj and Kahalu Upazila (sub-district) in the Bogra district. The physical and morphological characteristics, and the productive and reproductive performances of NBG cattle were studied. The coat colour of these animals is deep grey to white. The coat colour of the neck region in adult bulls was found to be generally ashy with a range of shades.

The body is small, compact and less fleshy. Ear length and ear width were 18.0±0.17 and 11.0±0.21 cm, respectively. The head length average was 38.0±0.56 cm, the head width 16.0±0.17 cm, the foreleg length average 65.0±0.64 cm, the hind leg length 71.0±0.64 cm, the tail length average 71.0±0.67 cm, the horn length average 9.0±0.39 cm, the horn diameter 10.0±0.37 cm, the average teat length 5.0±0.18 cm, the teat diameter 6.0±0.22 cm, the distance between the front teats 7.0±0.13 cm and the distance between the rear teats 7.0±0.13 cm. Body length, height at wither and heart girth in adult cows were 105.0±1.20, 94.0±1.12 and 127.0±1.52 cm, respectively.

The recorded highest peak milk production per day was 3.5±0.18 kg, lactation length was 219±6.1 days, and the dry period was 180±6.8 days. The average birth weight of calves was 18.4±0.52 kg and mature live weight of cows 241.0±4.0 kg. The age at first heat was 869±29.6 days, age at first calving 1191±19.7 days, gestation length 281±1.3 days, calving interval 442±7.4 days, postpartum heat period 110±4.2 days and the number of services per conception 1.4±0.6. About 54% of total cattle population was NBG cattle in the surveyed area of Bangladesh. The results indicated that the productive and reproductive performance of NBG cattle was better than other non-descript indigenous cattle of Bangladesh. The study further revealed an obvious need for more in-depth and objective information on wider samples of this type of indigenous cattle in order to assess the future need for conservation and improvement programs to be undertaken.

Resumen

La raza bovina North Bengal Grey (NBG) es una raza indígena de importante recurso genético que se encuentra en la zona norte de Bangladesh. El estudio se inició en Bogra Sadar, Shibgonj y Kahalu Upazila (Sub-distrito) en la región de Bogra. Se estudiaron las características físicas y morfológicas y los rendimientos productivos y reproductivos de la NBG. El color del manto de estos animales va del gris oscuro al blanco. El color en la zona del cuello en los machos adultos suelen presentar variaciones de gris.

Es un animal de cuerpo pequeño, compacto y poco carnoso. El tamaño de las orejas y circunferencia es de 18,0±0,17 y 11,0±0,21 cm, respectivamente. La medida de la cabeza es de una media de 38,0±0,56 cm, la circunferencia de 16,0±0,17 cm, la largura de las patas delanteras de 65,0±0,64 cm, la parte trasera 71,0±0,64 cm, la cola tiene una longitud de 71,0±0,67 cm, los cuernos 9,0±0,39 cm, diámetro de los cuernos 10,0±0,37 cm, las tetillas 5,0±0,18 cm, circunferencia de las tetillas 6,0±0,22 cm, distancia entre tetillas 7,0±0,13 cm, y distancia entre tetillas traseras 7,0±0,13 cm. La longitud corporal, altura a la cruz y circunferencia torácica en los adultos fue de 105,0±1,20; 94,0±1,12; y 127,0±1,52 cm, respectivamente.

El pico máximo de producción de leche por día fue de 3,5±0,18 kg, la duración de la lactación fue de 210±6,1 días, y el período seco fue de 180±6,8 días. La media de peso al nacimiento fue de 18,4±0,52 kg y el peso a la edad madura de las vacas de

241,0±4,0 kg. La edad al primer celo fue de 869±29,6 días, edad al primer parto 1.191±19,7 días, duración de la gestación 281,0±1,3 días, intervalo entre partos 442,0±7,4 días, periodo de celo post-parto 110,0±4,2 días y número de servicios por concepción 1,4±0,5. Alrededor del 54% del total de la población de NBG en el cuestionario provenía de la zona de Bengladesh. El estudio reveló posteriormente la necesidad obvia de una mayor información sobre amplias muestras de este tipo de raza indígena para poder establecer un programa futuro de conservación y mejora de la raza.

Keywords: *Genetic resource, Physical characteristics, North Bengal Grey cattle, Production, Reproduction, Measurements.*

Introduction

Bangladesh is an agricultural country. Livestock, being one of the major components of agricultural output (crops, livestock, fisheries and forestry) plays a vital role in national economy, contributing about 6.5% of Gross Domestic Product (GDP) and 13% of total foreign exchange earning (DLS, 1994). The total ruminant livestock population of Bangladesh is composed of 24.0 million cattle, 34.4 million goats, 0.83 million buffalos and 1.14 million sheep (FAO, 2002).

Bangladesh has high density cattle population. The relative density of the cattle population is well above the averages found in many other countries of the world. It ranks 12th in cattle populations in the world, and third among Asian countries (Alam *et al*., 1994). Despite such a highly dense cattle population, the country has been deficient in milk, meat and draught power for quite some time. The cattle resources of Bangladesh are mostly of the indigenous type (*Bos indicus*) with a substantial number of Sindhi, Sahiwal, Jersey and Holstein-Friesian crossbreeds. Indigenous cattle experience late maturity, short lactation length, long calving interval and poor production of milk and draught power but are more disease resistant and capable of thriving in harsh conditions (Majid *et al*., 1992).

In the developing world, the indiscriminate use of exotic animal genetic resources and poorly designed breeding schemes are the major reasons for the loss of animal genetic resources. The loss of locally adapted breeds will have long term negative implications, and in most instances, will reduce food security rather than ensure it. Cattle are an inseparable and integrated part of the agricultural operation. There are a few improved varieties of cattle such as Red Chittagong (RC), Pabna Milking Cow (PMC) and North Bengal Grey (NBG) localized in some areas of the country. These so called 'varieties' of cattle have neither been identified (either by phenotypic and genetic characterization) nor has any objective study been made on their conformation or productive and reproductive performance with larger sample sizes *in-situ*.

The North Bengal Grey (NBG) cattle may be one such promising variety of domestic animal genetic resource. The history of the development of this variety is not clear. The productive and reproductive performance of NBG cattle has not yet been well evaluated. The documented scientific information on various traits of these cattle is at present lacking, therefore the present study was undertaken to evaluate and characterize the North Bengal Grey (NBG) cattle of Bangladesh with the following objectives:

1. To study the probable distribution pattern of North Bengal Grey (NBG) cattle.
2. To morphologically characterize the North Bengal Grey (NBG) cattle.
3. To assess their productive and reproductive performances.

Location and Temperature

The study area is located between 24º 30´ and 25º 10´ latitude, and between 89º 00´ and 89º 40´ longitude. The mean annual temperature is about 26 º C. Mean monthly temperature ranges between about 18 ºC in January and 30 ºC in April-May. Extreme temperatures range between about 4 ºC and 43 ºC, except on the coast. Ground frost is occasionally experienced in exposed parts of the hill areas but not on the plains.

Materials and Methods

The three Upazilas (sub-districts) namely Bogra Sadar, Shibgonj and Kahalu under Bogra district were selected as the study area. These three selected Upazilas are situated on the Northern side of the Bogra district in Bangladesh. These areas were also chosen for the reason that most of the NBG cattle are found in that area, therefore the area was considered suitable to conduct field survey. The questionnaire was carefully designed keeping the purposes of the study in mind. The questionnaire contained both open and closed form questions.

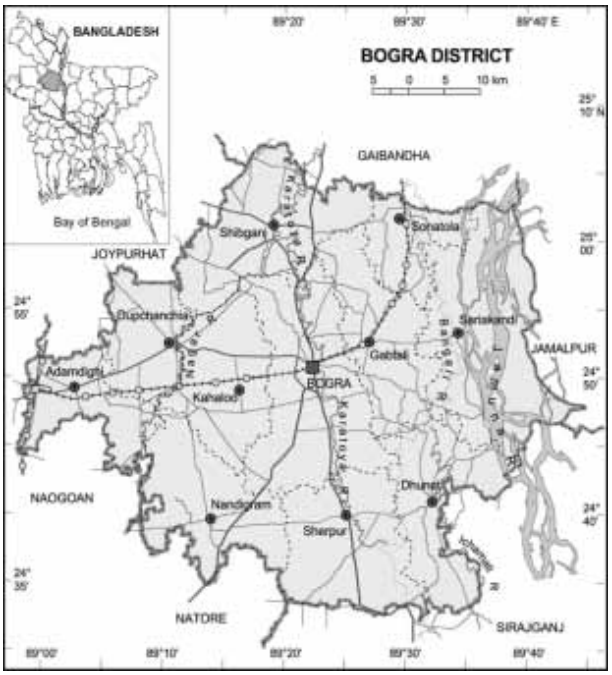

Figure 1. Geographic location of Bogra District in Bangladesh

Most easy, simple and direct questions were used to obtain information from the respondent farmers.

The questionnaire was pre-tested in order to judge its suitability for the respondents then finalized, necessary modifications having been made. Simple and direct questions were included in the questionnaire for the purposes of collecting information relating to the farmers such as age, education, occupation, family size, farm size, and for information relating to the cattle such as feeding management, production potential, reproductive characteristics, disease incidence, control measures and management of North Bengal Grey cattle. In this study, a total number of 100 animals were selected from three Upazilas, 40 from Shibgonj, 30 from Bogra Sadar and 30 from Kahalu. Animals were selected randomly as milking cows, dry cows, heifers, bulls, bullocks and calves

In order to collect relevant information an interview technique was used focusing on issues such as the farmers' socio-economic status, livestock population and genetic status, feeding regime, production potential, reproductive performance, physical characteristics, morphometric characteristics, disease control and management. In general, most farmers are not used to keeping any written information (records) on their livestock, so the researchers had to depend on the memory of the respondent for obtaining information. The information gathered in relation to the farmer himself was age, education, family size, occupation, and farm size. The livestock population referred to the total number of livestock, mainly cattle, reared by the farmer such as numbers of milking cows, pregnant cows, bulls, heifers, bullocks and calves of either sex. The genetic status of the livestock was determined on the basis of information provided by the farmers. The genetic status was mainly that of indigenous cattle, NBG Cattle and crossbred cattle.

Birth weights were taken directly with a balance. Adult body weight measurements were taken indirectly using Shaffer's method with the help of a measuring tape, i.e., body weight in kg = (L × G2 × 2.2)/300, where L is length (inch) from shoulder point to buttock and G is heart girth (inch).

Results and Discussion

Origin and distribution of NBG

The distribution of the target NBG cattle is presented in table 1. The graphical representation of NBG cattle is given in figure 1. Most of the interviewed farmers responded that the NBG cattle variety originated from the crossbreeding of local cattle with those imported from Bihar and Uttar Pradesh in India, in pre-independence days over a long period of time. This variety of cattle has good market value as a cart bullock in the Northern parts of the country and elsewhere (Nasim, 1965). The NBG cattle are available in the Northern regions of Bangladesh and although they are very rare in other regions, due to migration or trading it is not unusual to see NBG elsewhere in the country.

Feeding and management

The feeding and management system of NBG cattle in Bogra Sadar, Shibgonj and Kahalu area remained almost unchanged throughout the year. Stall feeding was mainly practiced although grazing was sometimes practiced, for example after harvesting crops in the field. Cattle mainly lived on rice straw and green grass. Most of the animals were not provided with any concentrate feeds.

Table 1. Distribution of NBG cattle in Bogra Sadar, Shibgonj and Kahalu Upazila of Bogra district in Interviewed Farmers.

Category	NBG (%)	Local (%)	Crossbred (%)
Milking cows	29.0	24.0	3.0
Pregnant cows	23.0	16.0	2.0
Bulls (Breeding)	22.0	24.0	2.0
Bulls (not used in breeding)	4.0	9.0	-
Heifers	29.0	9.0	4.0
Bullocks	4.5	4.0	1.0
Calves (Male)	9.0	8.0	-
Calves (Female)	8.0	4.0	1.0
Overall	54.0	41.0	5

Morphometric characteristics

Morphometric measurements (body length, height at wither and heart girth) were taken from 100 NBG cattle of different categories and are given in table 2. In all categories of the animals, heart girth was highest followed by height at wither and body length giving the appearance of a small, compact body. Males had greater body measurements when compared to females. Habib *et al.*, (2003) observed that the body length, body height and heart girth of adult Red Chittagon females were 114.38±1.56 cm, 107.71±0.93 cm and 139.85±1.63 cm respectively. For adult male the same measurements were 134, 125 and 168 cm, respectively. The mean morphometric measurements are presented in table 3.

Physical characteristics

The coat colour of NBG cattle was mostly deep grey to white with differing shades. The neck regions of adult bulls were an ashy shade, which is prominent and increases with age. The head was small and the colour of the muzzles, eyelids and hooves was black. Figures 2 to 5 show the distinct features of NBG cattle. Skin colour was predominantly black but in some of the animals was brown. The tail

Figure 2. A North Bengal Grey bull.

Figure 3. A North Bengal Grey bull.

switch was white in all animals. The horns were small to medium and curved inward with pointed tips (Figure 2 and Figure 3). The ears were small and erect with a sideways orientation and had pointed tips. The face was small and narrow with a flat forehead. The body was small, compact and less fleshy. The skin was tight, the dewlap was medium and the hump was small in females and developed in males (Figure 4 and Figure 5). The tail was long and reached to below the hock. Cows had small udders, teats and milk veins. The animals of this breed were usually quiet but adult males were of aggressive temperament. Figure 6 shows a NBG calf.

Production traits

Birth weight

Information on the birth weights of NBG cattle was gathered from 20 calves (Table 4). Habib *et al*. (2003) reported that the birth weight of RC calves was 17.24±0.68 kg in male and 16.0±0.66 kg in female

Table 2. Body measurements of NBG cattle.

Traits	Category	Number	Minimum	Maximum	Mean	S.D.
Height at wither (cm)	Cow	49	79	110	94	7.9
	Heifer	29	58	102	84	7.9
	Bull	17	67	105	93	9.7
	Overall	100	50	110	91	10.4
Body length at shoulder (cm)	Cow	49	67	120	105	8.5
	Heifer	29	61	115	88	13.9
	Bull	17	61	120	100	14.3
	Overall	100	61	120	99	13.8
Heart girth (cm)	Cow	49	103	154	127	10.7
	Heifer	29	73	145	101	16.2
	Bull	17	69	156	122	19.3
	Overall	100	69	156	117.8	18.5

Figure 4. A North Bengal Grey cattle with calf.

Table 3. Morphometric measurements of NBG cattle.

Characteristics	Number	Minimum	Maximum	Mean	S.D.
Ear length (cm)	100	13	22	18	1.7
Ear width (cm)	100	8	20	11	2.1
Head length (cm)	100	23	50	38	5.7
Head width (cm)	100	11	20	16	1.8
Fore leg length (cm)	100	46	78	65	6.5
Hind leg length (cm)	100	54	88	71	6.4
Tail length (cm)	100	43	90	71	6.7
Horn length (cm)	57	3	16	9	3.9
Horn diameter (cm)	57	4	16	10	2.8
Teat length (cm)	53	3	10	5	1.3
Teat diameter (cm)	53	3	10	6	1.7
Distance between fore teats (cm)	53	5	10	7	1.0
Distance between rear teats (cm)	53	5	10	7	1.0

with an average of 16.7±0.48 kg, which was lower than the results from NBG calves in the present study. Khan *et al*. (2000) observed the birth weight of RC calves in farm and rural condition to be 17.3±0.76 and 16.0±1.52 kg respectively which was very similar to the findings of Habib *et al*. (2003).

Body weight of mature cattle

The average body weight of mature NBG cows is shown in table 4. The mature live weight data was collected from 40 NBG cows. Khan *et al*. (2000) found the mature body weight of RC cows under farm and rural conditions to be 234.28 kg and 206.50 kg respectively, which is very similar to the results obtained in the present study.

Peak milk yield

The average peak milk yield observed in 29 NBG cows is presented in table 4. This estimate came from a sample of NBG cows at various stages of lactation, and should therefore fairly represent the daily milk yield in the NBG cow. Habib *et al*.

Table 4. Production performance of NBG cattle.

Characteristic	Number	Minimum	Maximum	Mean	S.D.
Birth weight (kg)	20	15	24	18.4	2.35
Mature body weight of cow (kg)	40	206	307	241.0	13.1
Peak milk yield (kg)	29	1	8	3.5	1.2
Lactation length (days)	39	150	365	219.0	38.2
Dry period (days)	39	60	240	180.0	42.4

Table 5. Reproductive performance of NBG cattle.

Traits	Number	Minimum	Maximum	Mean	S.D.
Age at first heat (days)	36	710	1460	869	177.3
Age at first calving (days)	36	1090	1460	1191	118.1
Gestation length (days)	36	269	300	281	7.9
Calving interval (days)	36	365	520	442	44.5
Postpartum heat period (days)	36	60	180	110	14.9
Services per conception	44	1	3	1.4	0.6

Figure 5. A North Bengal Grey cattle.

(2003) found the milk yield/d of RCC to be 2.55±0.11 litres. Khan *et al*. (2000) observed an average daily milk yield under farm and rural conditions to be 2.0±0.65 kg and 1.80±0.87 kg respectively which is lower than the results in the present study. Bhuiyan and Faruque (1993) analyzed the daily milk yield of 340 local cows and found it to be 1.63±0.72 kg which is also lower than that of the present findings. In another experiment Bhuiyan *et al*. (1992) found the average daily milk yield of local cows to be 3.00 kg. Jabbar and Ali (1988) found the milk production of local cows averaged 2.42±0.40 kg. From available studies a wide variation in milk yields in indigenous cows has been noticed and hints at an opportunity for selection among indigenous cattle resources in

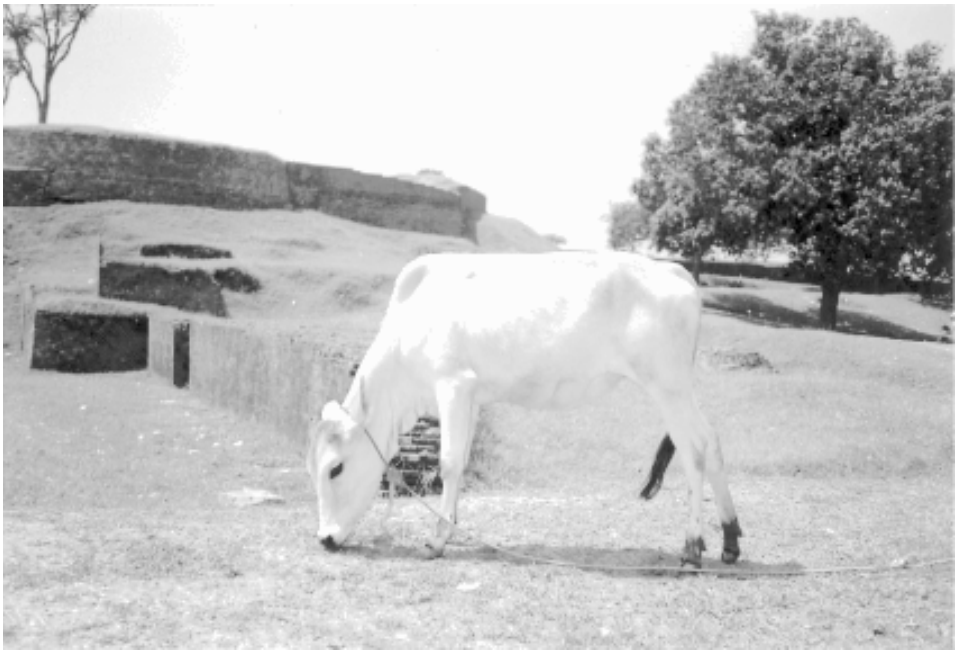

Figure 6. A North Bengal Grey calf.

order to increase milk yield in Bangladesh. Differences in genetic architecture, feeding systems, quality and quantity of rations, milker and time of milking may be affecting the daily milk yield of indigenous cows.

Lactation length (LL)

The mean lactation length (LL) along with SD of NBG cows is presented in table 4. Habib *et al*. (2003) reported a mean LL in RC cows of 261.08±14.51 days. Khan *et al*. (2002) studied the LL of RC cows and found it to be 222.85±16.03 days under farm conditions and 214.7±21.68 days under rural conditions. These results are close to that of the present study on NBG cows. Ahmed and Islam (1987) summarized the performance of local cattle for LL and found an average of 270 days, which is a little higher than the results of present study. Hoque *et al*. (1999) and Khan and Khatun (1998) studied the performance of PMC and found that LL ranged from 198.9±11.52 to 208.75±18.15 days which partially agrees with the findings of the present study.

Reproductive traits

Age at first heat

The mean age at first heat (AFH) along with SD for NBG cattle is presented in table 5. Rahman *et al*. (1987) investigated the AFH of local cows and found it to be 1283.19±41.93 days which is higher than the result of present study. Ashraf (1998) concluded that AFH of indigenous cows was 31.0±3.29 months. Ali (1994) showed that the AFH of local cattle was 42.40 months, which is higher than the result of present study. Fluctuations in age at puberty of various genetic groups of cows might be due to the effect of environment, varied management practices and heredity.

Age at first calving (AFC)

The mean age at first calving (AFC) along with SD for the NBG cattle is presented in table 5. Jabbar and Green (1983) reported the AFC of local cows to be 3.82, 3.85 and 5.45 years for non-draught, draught-1 and draught-2 cattle respectively, which is close to those in present study. Ghose *et al*. (1977) found that AFC was 1246.08±121.66 days for RC cattle. This result is very close to the results of the present study. Genetic and management factors especially feeding systems and methods of care might have influenced this trait.

Number of services per conception

The mean number of services required per conception (SPC) along with SD for the NBG cattle is presented in table 5. SPC information was

available on 36 cows only. Khan *et al*. (1999) studied the performance of RCC and PMC cattle and reported that SPC were 1.61±0.09 and 1.57±0.07, respectively. Habib *et al*. (2003) observed the average number of services required per conception for the RCC was 1.25±0.12.

Gestation length (GL)

The mean gestation length along with SD of NBG cows is presented in table 5. The overall gestation length for NBG cows was 281±1.3 days. Ahmed and Islam (1987) and Majid *et al*. (1999) found the GL of RCC cows to be 281.30±1.43 and 281.0±2.94 days, respectively – results which are very close to the results in the present study. Hossain and Routledge (1982), Khan and Khatun (1998) and Khan *et al*. (1999) reported the GL of PMC were 281.0, 283.61±8.23 and 279.10±1.04 days, respectively. These results are much closer to the values observed in the present study.

Calving interval (CI)

The mean calving interval (CI) along with SD for NBG cows is presented in table 5. Khan *et al*. (1999), Ahmed and Islam (1987) and Hasnath (1974) studied CI on RCC and their findings were 479.50±16.94, 458.40±71.82 and 485.0 days, respectively. These results are slightly higher than the findings of the present study. Habib *et al*. (2003) found the CI of RCC cattle was 409.9±17.8 days which is shorter than those in the present study. Halim (1992) studied local dairy cows and found they had an average CI of 445.0 days, which is very close to that found in the present study.

Postpartum heat period (PPHP)

The mean, SD, highest and lowest values of the postpartum heat period are shown in table 5. Information was gathered from 36 NBG cows only. Similar results had been shown by Nahar *et al*. (1989). They reported that in different breed groups PPHP ranged from 150.71±4.42 to 113.33±5.45 days.

Recommendations

The findings of the present study on the NBG cattle revealed that more systematic studies are needed to compare the production and reproductive performance of this variety of cattle with that of other indigenous cattle in Bangladesh. It is observed, however, that the NBG cattle variety is at risk both from man made and natural disasters, poverty and lack of awareness and/or interest by GO and NGOs operating in the country. Therefore, stakeholders of this cattle variety must devise and implement plans for concurrent conservation and sustainable development programs that are both practical and scientifically sound. Further, molecular characterization of NBG cattle to determine their genetic constitution is essential.

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The N'Dama cattle genetic improvement programme: a review

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Summary

This paper reviews the successful N'Dama cattle genetic improvement programme implemented in a low input production system at the International Trypanotolerance Centre (ITC) in 1994, in The Gambia. The first part of the paper presents the genetic improvement programme. The second part deals with the analysis of the genetic improvement programme. The success of the genetic improvement programme expressed through genetic progress and the benefits for the farmers is encouraging. Recommendations to strengthen the implementation process in the field are made.

Résumé

Cet article se donne pour objectif de passer en revue le programme d'amélioration génétique du bétail trypanotolérant N'Dama. La première partie de l'article fait découvrir le programme d'amélioration. La seconde partie traite particulièrement de l'analyse du programme, cette analyse se base sur le progrès génétique obtenu et les bénéfices que peuvent en tirer les éleveurs. Pour conclure, certaines recommandations pour le renforcement du programme d'amélioration génétique sont proposées.

Keywords: *N'Dama, Improvement programme, Low input system.*

Introduction

The ability of some local breeds to resist trypanosome infection has been recognised, allowing use of trypanotolerant stock to be considered one of the major methods by which sustainable animal production can be developed in tsetse-infested regions.

Open Nucleus Breeding Systems (ONBS) have been recommended in developing countries (Smith, 1988). Reports show that among the improvement programmes implemented, few are well designed, and are facing the bottlenecks of long-term sustainability and involvement of local farmers (Kosgey *et al*., 2003).

This paper reviews aspects of the N'Dama cattle genetic improvement programme implemented at the International Trypanotolerance Centre (ITC), in The Gambia.

Programme Implementation

The breeding goal

The goal was discussed and agreed upon with the National Agricultural Research Services and representatives of the target groups. In 1990, a Food and Agriculture Organization (FAO) consultancy mission was conducted at ITC. The report revealed the importance of traits like disease tolerance, milk production, meat production and ability for traction (Dempfle, 1990).

A Participatory Rural Appraisal (PRA) study was carried out in 1996 (Bennison *et al*., 1997). Based on the results, a bio-economic model was adapted utilising all known biological and economic relationships (Dempfle, 1986). This economic model was used to obtain an economic definition of the overall breeding goal. After reviewing the literature and the local production system, it was agreed in 1998 that the improvement programme should aim to increase milk and meat production without the loss of trypanotolerance and other adaptive traits.

Table 1. Overview of the chronological development of the N'Dama cattle genetic improvement programme.

Event	Period
Inception of ITC	1984
Food and Agriculture Organization (FAO) consultancy mission conducted at ITC	1990
Need for a coherent and comprehensive improvement programme expressed	1993
Proposal to support the organisation of the herd into an open nucleus herd	1993
BMZ agreed to financially support the proposal	1993
Launch of the programme	1994
Records on performance	1995
Workshop organized for breeding goal	1996
Purchase of replacement discussing animals (screening)	1996/1999
Breeding goal agreed	1998
Introduction of an animal model BLUP evaluation	1998
Introduction of mechanism to disseminate genetic progress	2001
Project PROCORDEL: enhance dissemination	2000
OPEC-FID: screening operation	2002
Establishment of two livestock multiplier associations	2002
Survey of farmer acceptance	2003

The breeding strategy

The strategy follows that of an ONBS, with selection based on individual performance and the performance of relatives. It is a three-tier scheme including the nucleus (ITC), multipliers and commercial farmers.

The following two activities can be distinguished:

1. generation of genetic progress; and
2. dissemination of genetic progress (Van Arendonk and Bijma, 2003).

To ensure that farmers use the genetic material, promotion of the improvement programme through communication with farmers and the government was very important. It involved a series of workshops, training, open days, farm visits, films and livestock shows, which demonstrated the benefits for the production of the N'Dama cattle breed.

Other programmes or activities also contributed significantly to the programme. Besides the technical aspects, socio-economic aspects have also been undertaken.

Selection criteria

Animals in the improvement programme are maintained under a low input management system and details on the production system have been described by Agyemang *et al*. (1988). Animals are selected according to an index containing information on daily weight gain (between 15 months and 36 months in a high tsetse challenge area) and the 0–100 day milk yields of all lactations. The index integrates information on the animal itself and all relatives using animal model BLUP methodology.

Selection candidates are located at the ITC's stations at Bansang (a high tsetse challenge area). The station located at Keneba maintains the breeding herd of five sires and 400 cows. Each year, approximately 400 cows are mated to produce 100 male and 100 female calves. These calves are maintained at Keneba until weaning after which 95 males and 90 females are moved to Bansang. At any one time, approximately 230 males and 225 female weaners are present at Bansang. At the end of the testing period (at 36 months of age), 84 male and 80 female animals are available for selection.

Each year one to two males are selected out of 84 candidates for replacement of the breeding males. The second best males (around 10) are designated for use in the multiplication tier, whereas all others are sold to butchers to be slaughtered. From the 80 female selection candidates, 75 are selected and mated after which 55 animals are retained based on their first lactation performance.

Training and dissemination of genetic progress

Training was the starting point for strengthening the activities of the improvement programme. The overall objective is to enhance the ability to implement genetic improvement programmes, to deal with the issues and problems faced in the management of local indigenous breeds and to cope with new technical developments for the sustainable use of local animal genetic resources.

The cattle dissemination programme started in 2001 (Table 1). As of February 2004, 44 improved bulls have been distributed to individual multipliers in 26 villages. In February 2004, 169 offspring were registered in these multiplier herds.

For the genetic improvement programme to have an appreciable impact, two livestock multiplier associations, Gambian Indigenous Livestock Multiplier Associations (GILMA-Saloum and Fulladu), were established.

Opportunities for Improvement and Evaluation of the Scheme

The evaluation is essentially based on two main interacting criteria: the genetic gain achieved during the development of the genetic improvement programme and the uptake of results by farmers. We also want to address the question of the extent to which farmers and farming communities in Gambia and the West African region benefit from changes brought about by the genetic improvement programme.

Genetic gain

Collection of performance data over 10 years has permitted the estimation of genetic parameters as well as the genetic trends for growth traits (Figure 1). The estimated heritabilities for growth traits recorded in the scheme were moderate to high (Bosso *et al*., 2002), ranging from 0.28 for weight at 36 months to 0.48 for weight at 15 months. The

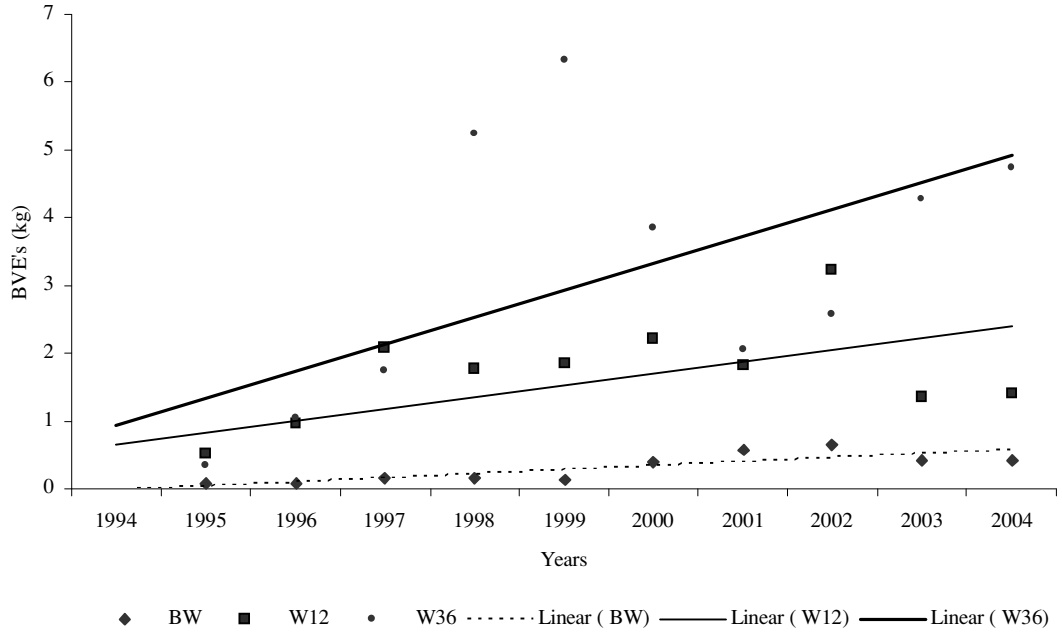

Figure 1. Figure 1. Genetic trend from 1994 to 2004 for body weight traits, showing the correlated selection responses per year for EBV of W36 (weight at 36 months of age), BW (birth weight) and W12 (weight at 12 months of age).

Figure 2. N'Dama cattle in its environment.

genetic correlation between weaning weight and weight at 36 months was high (0.69). Genetic and phenotypic parameter estimates are scarce in pure bred indigenous N'Dama cattle populations (Figure 2) and coupled with the results of the heritability factors, they support the promise of genetic improvement with respect to growth rates.

Average estimated breeding values (EBV's) of animals were calculated. The estimated increase in breeding value for W36, from 1994 to 2004, fluctuated between 0 to 6.32 kg.

W36 exhibited the largest genetic gain with a response of 0.40 kg per year. The other weight traits also exhibited positive, although smaller, amounts of genetic gain.

Support to farmers' associations

The newly formed associations remain fragile and more work is needed to strengthen them to improve their access to innovations, markets and services that enhance farm productivity and income. It is also essential to make the members of the associations aware that these associations are first and foremost instruments for them and respond to precise needs.

Interaction with farmers

A survey was conducted in 2003 in The Gambia. The objective was to assess the adoption of the genetic improvement programme. One of the most important benefits to farmers is the savings generated by the utilization of improved males; the cost of trypanocide drugs to control trypanosomosis and other diseases is drastically reduced (50%). This is very encouraging and is likely to translate in the future into higher mature live weight of animals and therefore higher sale prices.

Utilization of Indigenous Breeds

Given the encouraging results of the N'Dama genetic improvement programme in The Gambia, it has been shown to play an important role in the conservation and utilisation of N'Dama cattle. The programme has significantly influenced the utilisation and development of the N'Dama breed.

Benefits to farmers and cost of the improvement programme

The programme meets the important characteristics required for estimating incremental cost, because:

1. it addresses national development goals;
2. it is technically feasible;
3. it is economically attractive, while remaining broadly consistent with political and social constraints;
4. it is environmentally reasonable; and
5. it is financially realistic.

It appears that the N'Dama cattle genetic improvement programme will also benefit countries other than The Gambia.

Conclusion and recommendations

The N'Dama cattle improvement programme demonstrates that genetic improvement programmes for a low input production system are feasible. The success of the programme is expressed by the genetic progress achieved and this success has been transmitted to the farmers through the involvement of farmers and farming communities.

Acknowledgments

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The Poltava chicken breed of Ukraine: its history, characterization and conservation

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Summary

Poltava chickens are native to Ukraine, with a remarkable history, genetics and economic traits. They include three varieties: Clay, Cuckoo and Black. The Poltava Clay variety exemplifies what can be achieved by thorough selection in transforming a local, low production chicken population into an established breed with high performance characteristics and selected line structure. Two other varieties, the Cuckoo and Black, are extinct but plans for their restoration are underway.

Resumen

Las aves Poltava son originarias de Ucrania y poseen unos rasgos genéticos y económicos y una historia importante. Incluyen tres líneas: Clay, Cuckoo y Black. La línea Poltava Clay es un ejemplo de lo que se puede conseguir a través de la selección transformando una población local de aves de baja producción en una línea estable con características de alto rendimiento y estructura selecta. Las otras dos variedades, Cuckoo y Black, se han extinguido pero existen planes actualmente para su recuperación.

***Keywords**: Characterization, Chicken, Conservation, History, Poltava, Ukraine.*

Introduction

The name of the Poltava chickens of Ukraine is derived from the name of Poltava city and region. This is one of the central, long-established regions of Ukraine, which retains the old traditions of livestock breeding and farming. The breed used to include three varieties: the Clay, Cuckoo, and Black. They were registered as local populations during an expeditionary poultry survey in the 1920's (Ferdinandov, 1948), however, breed founders had already been exhibited at a poultry exhibition in Poltava in 1895. The selection of Poltava chickens for improved performance and reproduction was initiated in 1912 at the Poltava Experiment Station. At that time, their yearly egg production was 70, average egg weight was 50 g, and body weight 2.1 to 4 kg (Ivanova and Kovalenko, 2003; Mosyakina *et al.*, 2005).

At the first and second all-Ukrainian egg production competitions in 1928-1929, the Poltava chickens demonstrated an extraordinary production of 100 eggs per hen, with the best layers having produced 164-169 eggs in the 259 days of the test (Romanov and Bondarenko, 1994). However, in the following years (1930-1941) most collective farms switched to breeding White Leghorns and other standard breeds. During World War II and the post-war years, changes in agriculture policies induced by the deleterious innovations of the Lysenko and Khrushchev parties, the transition to industrial poultry production and other state measures resulted in the continued decline of native breeds. To propagate and preserve native chicken populations, eggs of

Dedication: The authors dedicate this paper to the memory of their senior colleague and teacher Vera Dmitrievna Lukyanova (1927-2006), the former Director of the Poultry Research Institute (UAAS), Borky, who contributed to the breeding and selection improvement of the Poltava Clay chickens in the 1960s-1990s.

Poltava chickens were imported to the Ukrainian Poultry Experiment Station (now the Poultry Research Institute, PRI) in Borky, Kharkiv Region, from the Poltava Region in 1948-1949. Before 1953, this core breeding flock was subject to mass selection coupled with individual selection. Later on, more intense selection was undertaken to improve the Poltava breed including all three varieties (Clay, Black and Cuckoo), which was supported by a special decree by the Ukraine Ministry of Agriculture (Len', 1959; Ivanova and Kovalenko, 2003; Mosyakina *et al.*, 2005).

Poltava Clay

The Clay variety is presumed to have been known in Poltava Province from the mid 19th century. It was derived from local fowls crossed with Buff Orpingtons (Savelyev, 1953; Romanov and Bondarenko, 1994) or other exotic breeds such as New Hampshire, Wyandotte, etc. (Mosyakina *et al.*, 2005). From 1951 an improvement of the Clay variety was begun. In 1965, worthwhile strains were chosen and selection, combined with progeny testing of sires, commenced. Since 1970, these selected strains have been tested for general and specific combining abilities (Lukyanova and Kovalenko, 1979).

By January 1, 1985, there were 714 385 Poltava Clays at the collective and state farms of the former USSR. However, since 1991 there has been a significant decline in livestock and poultry production and an overall gene pool loss, factors that also affected the state of the Poltava chicken breed. By 1994, a total of 3 300 purebred Clay chickens remained (Romanov and Bondarenko, 1994). In 2003, the Borky farm as an accredited Poltava Clay breeding centre and primary producer had 6 000 individuals. In addition, five more primary and secondary producers supplied this breed to state and private farms in Ukraine (Ivanova and Kovalenko, 2003; Mosyakina *et al.*, 2005). Information about Poltava Clays was incorporated into the FAO DAD-IS Breeds Database (FAO, 1996) and the World Watch List for Domestic Animal Diversity (Scherf, 1995, 2000).

Clay chickens are not particularly large birds, with a horizontal posture and legs of medium length and yellow colour (gene *ID*ID*) (Figure 1). Their comb is rose (*R*R*) or less frequently single (*R*N*). Their plumage colour ranges from buff to dark buff (genes of wheaten colouration *MC1R*WH, MC1R*Y, MH*MH, DI*DI, CB*CB*, and of gold *S*N*),

Figure 1. A cock of the Poltava Clay variety.

Figure 2. A hen of the Poltava Clay variety.

and is of a "black-tailed" Columbian type (*CO***CO*). Clay chickens are somewhat larger than the Cuckoos and Blacks (Len', 1961).

The Poltava Clay has been subject to morphotypological characterisation (Nikiforov *et al.*, 1998) and assessment for blood groups (Podstreshny, 1980; Gintovt *et al.*, 1984), and blood serum and egg white proteins (Bondarenko, 1976; Moiseyeva *et al.*, 1989). As a result of these studies, Poltava chickens were found to be closer to breeds of Asian origin including dual-purpose breeds from Russia and China. Romanov and Weigend (2001) included two Poltava Clay strains, P6 and P14, in a microsatellite diversity study of 20 populations. Both Poltava strains were clustered together with commercial and other strains derived from Rhode Island Reds and New Hampshires (Figure 2). In a large-scale survey (AVIANDIV, 2001), estimation of polymorphism degree for 25 microsatellite markers resulted in somewhat greater values in the Poltava breed in comparison with the "world" gene pool.

Clay chickens are well adapted to local conditions, can forage effectively and are undemanding feeders. They have broodiness and an overall calm demeanour and can be reared both on floors and in cage batteries of various types including individual cages for artificial insemination. The Poltava Clay is a dual-purpose breed, but some strains were selected with a bias towards egg or meat productivity. In strains selected for body weight, the cocks weigh up to 3.2 kg, and the hens 2.2 kg. Strains selected for egg production produce 210-240 eggs in 72 weeks. The breed is subject to continuous selection for increased viability, resistance to stress, neoplasms and Marek disease. Eggshell colour is brown (Ivanova and Kovalenko, 2003; Mosyakina *et al.*, 2005). Chicks are early feathering (gene *K***N*) and fast growing (Bondarenko, 1995). Clay fowls are more resistant to Rous sarcoma virus and neoplasms as compared to White Leghorns and White Russians (Stolyarenko, 1970; Kovalenko and Stolyarenko, 1982).

Poltava Clays are used as a dam strain in crossing with White Leghorns. Hybrids are resistant to oncoviruses, have brown eggshell, produce 222-243 eggs per hen housed and 235-252 eggs per hen survived for 69 weeks of life. Synthetic lines ('polycrosses' of three to nine lines) were developed based on Poltava Clay chickens including two lines combining Poltava Clay and Rhode Island Red strains (Lukyanova and

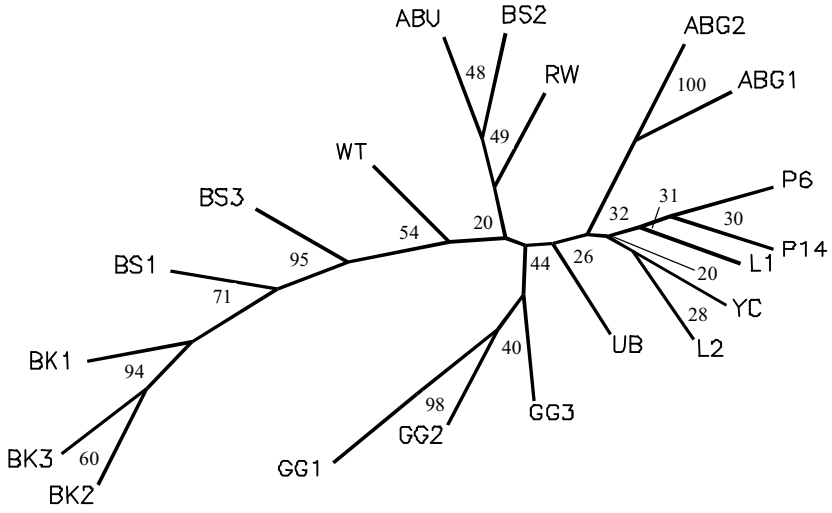

Figure 2. Dendrogram of phylogenetic relationships among 20 chicken populations, using Nei's (1972) standard genetic distance and the NJ method, based on 14 microsatellite loci. Consensus tree: numbers at the nodes are percentage bootstrap values from 1000 replications with resampled loci. Ukrainian populations: Ukrainian Bearded (UB), Poltava Clay (P6, P14), Yurlov Crower (YC), and Australorp Black (ABU). German populations: Red Jungle Fowl (Gallus gallus; GG1, GG2, GG3), Bergische Kräher (BK1, BK2, BK3), Bergische Schlotterkämme (BS1, BS2, BS3), Ramelsloher White (RW), Westfälische Totleger (WT), Australorp Black (ABG1, ABG2), and commercial layer lines (L1, L2) (from Romanov and Weigend, 2001).

Kovalenko, 1979; Romanov and Bondarenko, 1994; Ivanova and Kovalenko, 2003).

Poltava Cuckoo

The period of development of the Cuckoo variety is presumed to be the 19th century. Original forms are unknown (Figure 3), although the relationship with Barred Plymouth Rocks is repudiated (Savelyev, 1953). In 1954, the Cuckoo population was 33.8 thousand birds. Currently, it is probably extinct (Mosyakina et al., 2005). The body constitution of the Cuckoo corresponds to that of egg type fowls (Figure 4 and 5). The comb is predominantly rose (gene *R*R*) or single (*R*N*), and earlobes are red. In plumage colour, they resemble the Barred Plymouth Rock (genes *BARR*BARR*, *MC1R*E*), but unlike the latter are characterised by interchanging light grey and dark grey bars. Cocks are lighter than hens (Penionzhkevich, 1962).

Poltava Black

The variety is presumed to have been developed in the 19th century. Its ancestors are unknown. In the past, Black fowls were reared in Lubny District (Penionzhkevich, 1962). They numbered 42.9 thousand birds in 1954 (Solodky, 1956) and 8.5 thousand birds in 1964 (Iofe, 1968). At present, the variety is extinct (Mosyakina et al., 2005). Their body size is relatively small (Figure 6 and 7). The chickens have a rose (gene *R*R*) or single (*R*N*) comb, and a short, black beak. The self-black plumage colour (*MC1R*E*) is not glittering but dull in the females, and often glittering in the males (Len', 1959; Romanov and Bondarenko, 1994; Romanov *et al.*, 1996; Ivanova and Kovalenko, 2003; Mosyakina *et al.*, 2005). Legs are slate (*ID*N*).

In 2005, a plan to restore the Cuckoo and Black varieties was developed at the PRI because they had good potential for performance and were quite numerous and competitive.

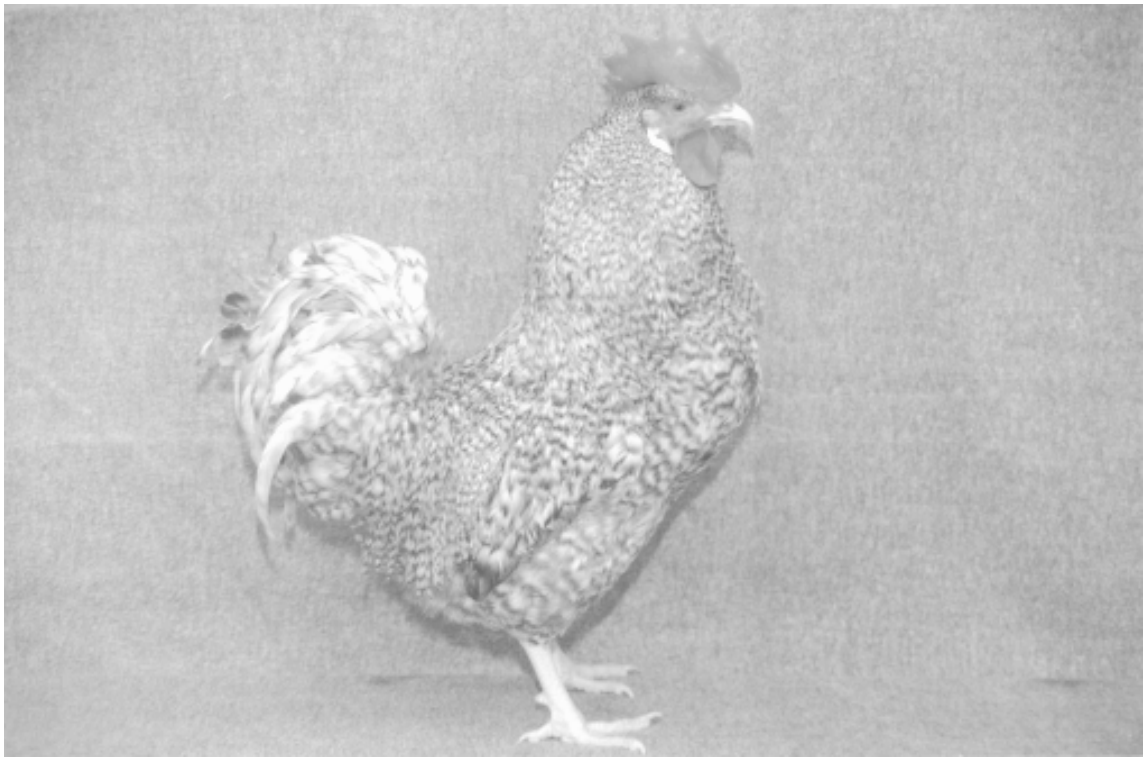

Figure 4. A cock of the restituted Poltava Cuckoo variety.

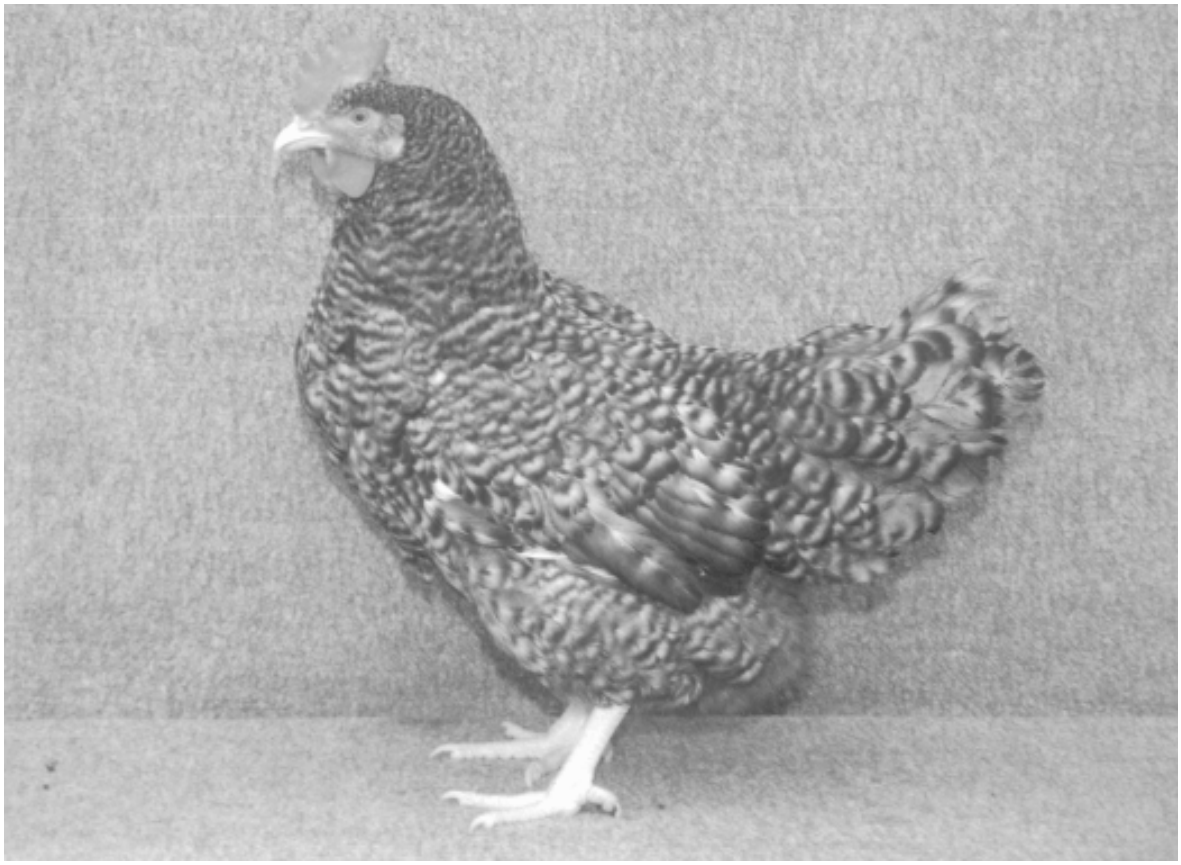

Figure 5. A hen of the restituted Poltava Cuckoo variety.

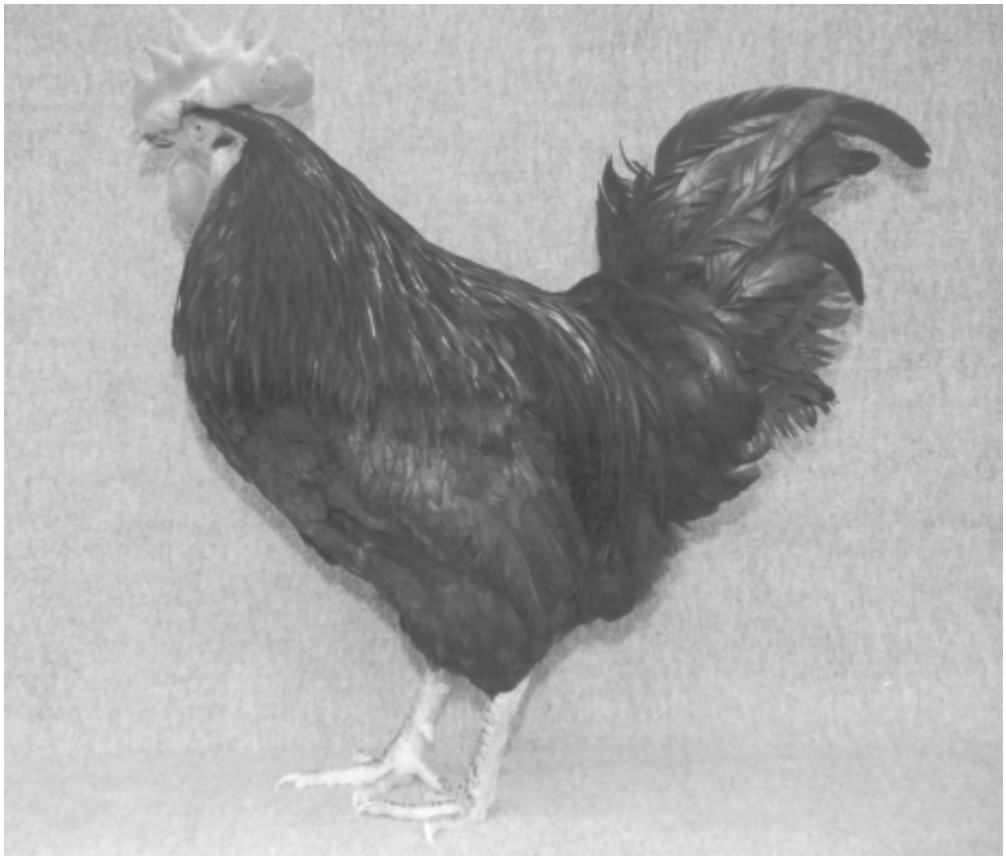

Figure 6. A cock of the restituted Poltava Black variety.

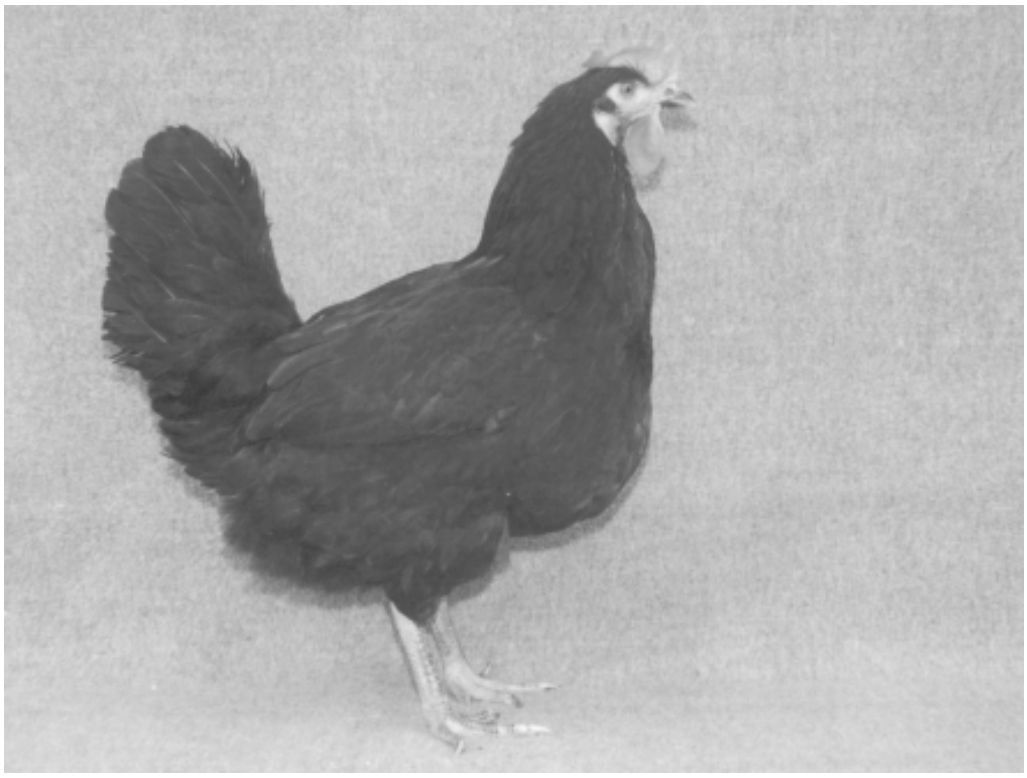

Figure 7. A hen of the restituted Poltava Black variety.

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Pure line laying chickens at the Agassiz Research Centre

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Summary

Six lines of laying chickens representing high-producing non-industrial lines chosen or produced with consideration for characters of production are being kept at the Agassiz Research Centre. The collection includes one Barred Plymouth Rock (Line 60), one Columbian Plymouth Rock, one Rhode Island Red (Line 50), and three White Leghorn lines (Blue, Black, and Burgundy). Before coming to the Agassiz Research Centre these pure lines were subjected to mild selection for egg production and their egg production approaches that of commercial hybrids. The lines are currently maintained as a genetic resource as live populations without selection and with populations large enough to minimize inbreeding. In addition, samples of DNA from these lines have been conserved for genetic studies, and samples of embryonic cells are being kept cryogenically to allow the possibility of reconstitution of the lines through the production of germline chimeras. Techniques of ovarian transplantation are being developed which will allow more efficient cryogenic conservation and recuperation of the genetic material into live populations.

Résumé

Six lignées de poules pondeuses représentant des lignées de hautes production mais non industrielles choisies ou produites en considérant des caractères de production sont gardées au centre de recherches d'Agassiz. La collection inclut une lignée de Plymouth Rock Barrée (Lignée 60), une de Plymouth Rock Colombienne, une de Rouge de Rhode Island (Lignée 50), et trois lignées Leghorn Blanches (Bleu, Noir, Bourgogne). Dans le passé, ces lignées ont été soumises à la sélection pour les caractères de production et la production d'œufs des ces lignées pures s'approche à celle des lignées hybrides commerciales. Ces lignées sont actuellement maintenues comme ressources génétiques comme des populations vivantes sans sélection avec des populations suffisamment grandes pour minimiser la consanguinité. En plus, des échantillons d'ADN des ces lignées sont gardés pour les études de génétique et des échantillons des cellules embryoniques sont gardés en congélation pour permettre la reconstitution de ces lignées par moyen des chimères des lignées de cellules germe. Des techniques de transplantation ovarienne sous développement vont permettre la conservation cryogénique plus efficace avec récupération du matériel génétique dans les populations vivantes.

Keywords: *Laying chicken, Middle level poultry, Genetic conservation, Cryogenic storage.*

Industrialization of Chicken Breeding in Canada

In 1946, 263 breeders of laying chickens were entered in Canadian Record of Performance programs. At that time, there may have been another 40 breeders of chickens, as many as 20 breeders of turkeys and up to 18 breeders of waterfowl. By 1980, Crawford (1984a) was able to find only 13 middle-level poultry breeders in Canada, defined (Crawford, 1984b) as breeders of those traditional breeds that were usually kept for both meat and eggs. These breeders kept a total of 20 stocks, including 11 strains of chickens, one of turkeys, and eight of waterfowl. Most of these lines have since been lost.

At one time, poultry meat and eggs in Canada were produced from middle-level lines. However, in the 1950s and 1960s, some breeding companies began to dominate the market not only in Canada but around the world and produced stock that was specialized for production of either meat or eggs (Carter, 1964). Consolidation resulted in a progressively smaller number of companies, now

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known as primary breeders, which maintained breeding populations, practiced selection for commercial production, and sold hybrid individuals that would become the parents of commercial offspring.

Canada has been home to two of these primary poultry breeders. According to Crawford (1984b), Hybrid Turkeys Ltd. was a family-owned company in 1979, but was subsequently purchased by a corporation based in The Netherlands. The other major Canadian primary breeder was Shaver Poultry Breeding Farms Ltd., which sold both layer and broiler chickens but was a dominant force in the international layer market. Crawford (1984b) reported that Shaver Poultry Breeding Farms Ltd. kept a large reserve of genetic resources. In 1985, D. McQ. Shaver retired as Chairman and Chief Executive Officer of the company and Shaver Poultry Breeding Farms Ltd. is now owned by Hendrix Breeding Farms, one of only two major primary breeding companies of laying chickens in the world.

In his retirement, D. McQ. Shaver became involved in poultry breeding as a non-commercial hobby and acquired eight lines of laying chickens which he kept for a number of years. In 2003, six of the lines were transferred to the Agassiz Research Centre of Agriculture and Agri-Food Canada. A policy on the release of these lines to interested parties is currently under development. This report is a description of these six lines of laying chickens.

Background of the Agassiz Lines

The six layer lines kept at the Agassiz Research Centre include one Barred Plymouth Rock (Line 60), one Columbian Plymouth Rock, a Rhode Island Red (Line 50), and three White Leghorn lines (Blue, Black, and Burgundy). General descriptions of these breeds are provided by the American Poultry Association (1983). Before coming to the Agassiz Research Centre, the lines were maintained by producing 425 females and 80 males in each generation. Production of the females was recorded and the best 200 were chosen on the basis of egg production, early egg size, and egg shell quality, with minor selection for egg colour. Males from the best 75 females were used for the next generation. This mating system should result in an effective population size of 218 and an increase in inbreeding of 0.229% per generation (following Falconer, 1989).

The Barred Plymouth Rock (Line 60) originated in the late 1950s from Harco stock, a well known line from Massachusetts. Before coming to the Agassiz Research Centre, it had been maintained by pedigree matings for more than 50 generations. The *K* gene has been maintained in Line 60 which would allow feather sexing if desired. This line could be crossed (as the mother line) with the Rhode Island Red (Line 50).

The Columbia Plymouth Rock Line was synthesized in the early 1960s from several stocks carrying the silver gene, *S*, (Light Sussex, White Leghorn) or others (Rhode Island Red) and the population was closed in about 1972. Mating females of this line (*S*-) with Rhode Island Red males (*ss*) allows the male and female offspring to be separated on the basis of colour. This line is considered to be a very rustic line.

The Rhode Island Red (Line 50) is considered to be from the long established Warren strain. The line is known to cross well with Barred Plymouth Rocks and Columbian Plymouth Rocks, which was confirmed by testing both in-house and at the University of Guelph. Before coming to the Agassiz Reseach Centre, Line 50 was reproduced for more than 50 generations by pedigreed matings. It is known for its rusticity and the ability to perform on sub-optimum nutrition levels. The slow feathering *K* gene is maintained in the line to allow feather sexing if needed.

The Blue White Leghorn Line was synthesized in the late 1970s from commercial stocks that were known for high interior egg quality, to which the Cornell K Line (Cole and Hutt, 1973) was added to increase resistance to leukosis. The Blue Line has been used as the mother of a hybrid, with the Burgundy line as father, which is used as the mother of a cross to the Black line.

The Black White Leghorn Line was founded on Tancred and Hollywood lines in the late 1920s and has been maintained by pedigree matings from then until it came to the Agassiz Research Centre. This line is known as a male line and has been crossed to the Blue line either as a two-way cross or in a three-way cross including the Burgundy line.

The Burgundy White Leghorn Line was developed from three commercial lines. The fast-feathering gene, *k*, has been eliminated and the inclusion of slow feathering, *K*, allows this line to be crossed to a fast-feathering line to produce a feather-sexable cross. The Burgundy line has been used as the father of a mother line, with the hybrid being crossed to the Black line.

Management and Data Collection

Eggs are incubated artificially, chicks are reared until 16 weeks of age in groups of 30, and pullets are subsequently caged in groups of three. Feed and clean water are provided to allow for *ad libitum* consumption. Day length is kept at nine hours until 18 weeks, when it is increased to 14 hours. A standard vaccination program for the area is used.

Production data were recorded in the first generation after the chicks arrived at the Agassiz Research Centre. Body weight was monitored during the rearing period and recorded for individual birds at housing (16 wk) and at 20, 40, and 60 weeks of age. Egg production was measured for five days per week and extrapolated to seven days, and egg weights were recorded at 30, 40, 50, and 60 weeks. Data was recorded to 40 weeks of age for the Black and Blue lines and to 60 weeks of age for the other four lines.

Production Results and Discussion

The general appearance of the hens is shown in figure 1. The three lines of White Leghorn have a very similar appearance and only one is shown to represent all three. The feather colour and pattern of each of the lines is as described by the American Poultry Association (1983). However, these lines

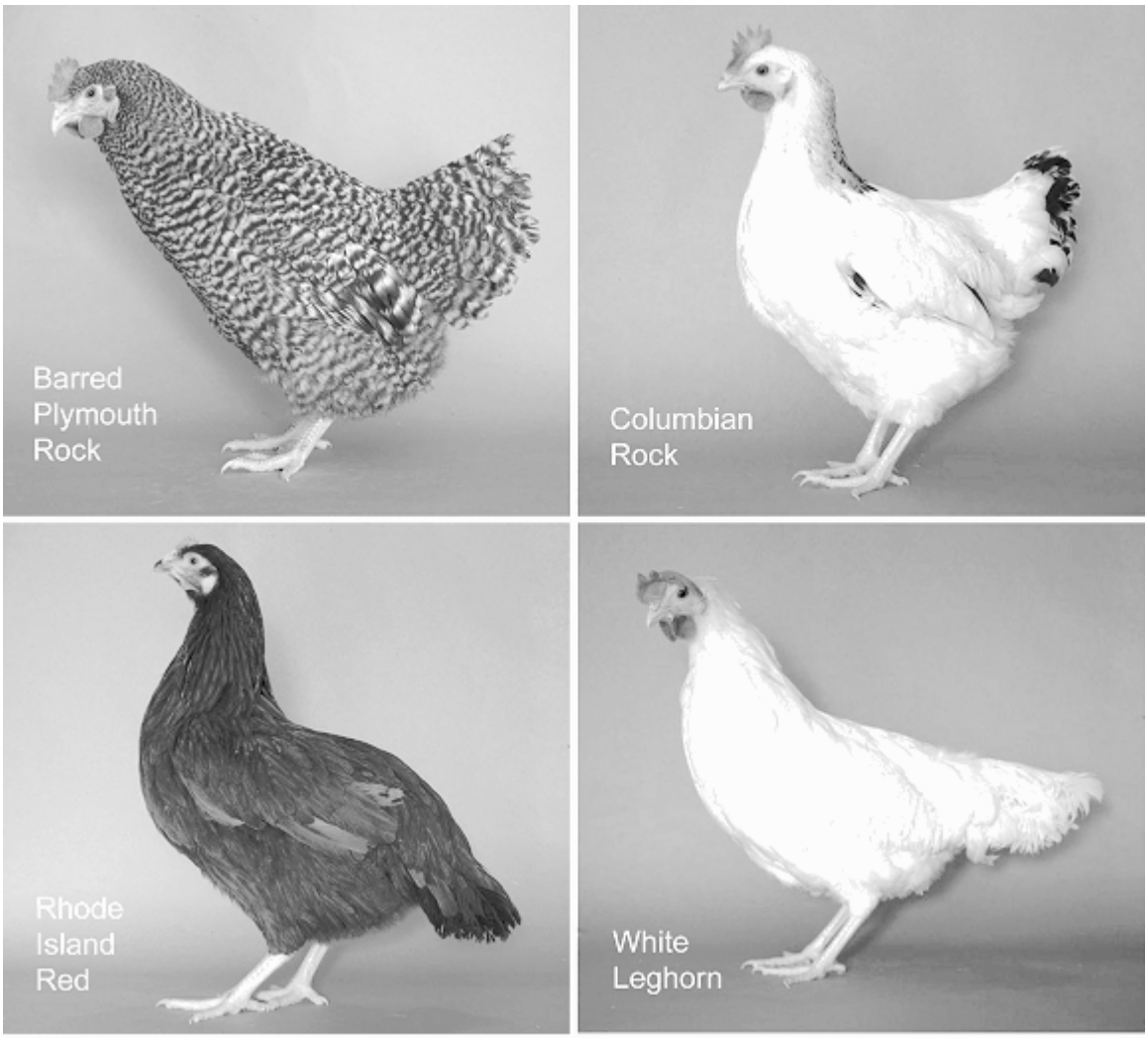

Figure 1. Barred Plymouth Rock (Line 60), Columbian Plymouth Rock, Rhode Island Red (Line 50), and White Leghorn (Black, Blue, Burgundy Lines) hens.

have not been selected for exhibitions and the colour and pattern demonstrate variation that the American Poultry Association (1983) would consider to be defects. These do not affect production characteristics.

The American Poultry Association (1983) provides standard body weights for cockerels and pullets, defined as male and female birds less than a year old. At 40 weeks of age, body weights of these six lines (Table 1) are all lower than the cockerel and pullet weights described by the American Poultry Association for these breeds, except that Black line males are very close to the American Poultry Association standard of 5 lbs (2 273 g). Lohman (2005a) expects their LSL-Lite hen to weigh 1 593 g at 40 weeks which is very close to the Black, Blue, and Burgundy lines. The Lohman Brown Classic Guide (Lohman, 2005b) shows a range of body weights from 1 848 to 2 042 g at 40 weeks, which encompasses body weights for females of the Barred Plymouth Rock, Columbian Plymouth Rock, and Rhode Island Red females. Synthesis and selection of these lines for production characteristics appears to have produced body weights nearer to commercial than fancier standards.

Management guides (Lohman 2005a, 2005b) also give expected egg production of hybrid commercial hens. Peak production of LSL-Lite hens is expected to be 94.2 hen-day-percent at 31 weeks with greater than 90 % hen-day production for 23 weeks, and that for Lohman Brown Classic hens should be 93.0 hen-day-percent at 28 weeks with greater than 90 % hen-day production for 14 weeks. Lohman expects their LSL-Lite hybrids to produce 126.6 eggs to 280 days of age (247.3 eggs to 420 days) and their Classic Brown hens to produce 128.0 eggs to 280 days of age (243.3 eggs to 420 days).

The egg production levels of the Agassiz pure lines are less than that expected for commercial hybrids (Table 2). Only the Rhode Island Red line reached the same peak production as expected for Lohman lines (93.0 hen-day-production), although peak production for the Barred Plymouth Rock, Black, and Burgundy lines approached that expected from Lohman hybrids. Hen housed egg production of Black line hens to 40 weeks of age was only 2 eggs lower than that expected of Lohman LSL-Lite hens and that of Blue line hens was only 4.5 eggs less. Fairful (1990) summarized research showing that heterosis for egg production traits is consistent and substantial, with a range of -3 to 40 % but commonly above 10%. The egg production of the Agassiz pure lines shown in table 2 suggests that hybrids produced by these lines could be expected to equal or exceed that of common commercial hybrids.

The high egg production of these lines may have been obtained at the expense of egg weight (Table 3) because of the negative correlation between egg production and egg weight (Fairful and Gowe, 1990). Weight of eggs from a commercial white-egg line (Lohman, 2005a) can be expected to be 59.2 g at 31 weeks and 61.9 g at 41 weeks, which is clearly more than that seen for the Agassiz White Leghorn lines. Egg weight from the Agassiz Brown-egg lines was also lower than expected for commercial hybrids (Lohman 2005b). Although early egg weight was low for both white and brown-egg lines, it increased more rapidly than expected from commercial lines over the production cycle. Eggs in North America are marketed on the basis of grade which is largely based on egg size, and the most valuable egg size is 56 to 60 g. Egg size of the Agassiz pure lines fell within this range for most of the production cycle.

Conservation Plans

At the Agassiz Research Centre, the six lines are kept as populations of at least 160 females (more if space allows) and 64 males per line which should result in an effective population size of 183 and an increase of inbreeding of 0.27 % per generation (following Falconer, 1989). Lines are reproduced yearly using artificial insemination. Semen from groups of eight males is mixed and used on 20 females. No selection is practiced except against obvious defects.

Samples of DNA were obtained from 15 males and 15 females of each line of the original populations that came to the Agassiz Research Centre. Following techniques from J. E. Fulton (Hy-Line International, personal communication), forty ml of packed RBCs were suspended in 3 µl of lysis buffer (10 mM Tris-HCl pH8.0, 400mM NaCl, 2mM disodium EDTA), to which 200 µl 10% SDS was subsequently added. The mixture was digested with 16 µl proteinase K (20 mg/ml) overnight at 37°C with shaking, and the protein was removed by adding 2 ml of 5M NaCl to each sample, after which the DNA was precipitated by ethanol. Samples are stored at – 20°C.

Primordial germ cells, harvested from embryonic blood or the primitive gonad, can be cryopreserved and used to generate germline chimeras, allowing the preservation of both male and female germplasm (Petitte, 2006). Creation of germline

Table 1. Body weights (g ± SD) of male and female chickens from six lines.

	Males					Females			
Line	No.	16 wk	20 wk	40 wk	60 wk	n (> 20 wk)	16 wk	20 wk	40 wk	60 wk
Barred Plymouth Rock	64	1 999±174	2 349±223	2 736±253	3 139±307	156 (135)	1 445±123	1 783±159	1 997±201	2 109±238
Columbian Plymouth Rock	64	1 848±166	2 032±209	2 377±280	2 783±343	156 (135)	1 334±137	1 666±178	1 878±248	1 989±289
Rhode Island Red	64	2 135±178	2 360±206	2 737±246	3 185±290	156 (134)	1 488±114	1 817±157	2 045±238	2 164±258
Blue	64	1 471±102	1 712±123	2 063±183	-	150	1 119±102	1 394±122	1 516±169	-
Black	64	1 551±115	1 888±151	2 311±207	-	150	1 167±99	1 497±127	1 666±165	-
Burgundy	64	1 625±145	1 773±148	2 062±166	2 354±195	156 (130)	1 157±93	1 450±123	1 630±162	1 701±207

Table 2. Egg production of six lines of laying hens.

	Hens	Peak production		Weeks above 90%	Hen housed egg production (±SD)	
Line	housed[1]	% hen day	Age (wk)	hen-day production	To 280 days of age	To 420 days of age
Barred Plymouth Rock	270	91.6	24	5	117.9±8.1	223.2±15.0
Columbian Plymouth Rock	270	87.9	24	0	116.7±10.6	215.5±24.4
Rhode Island Red	273	93.0	26	7	120.6±10.6	228.8±23.0
Blue	312	90.0	25	2	122.1±12.4	-
Black	312	92.6	25	7	124.6±10.8	-
Burgundy	273	92.4	27	6	120.7±10.6	228.8±23.5

[1]Housed in cages holding three hens each.

Table 3. Weight of eggs from six lines of laying hens.

Line	No.	Week 31	Week 41	Week 51	Week 61
Barred Plymouth Rock	83 to 139	55.2±3.4	58.7±4.0	60.3±4.0	61.1±4.4
Columbian Plymouth Rock	72 to 127	54.1±4.5	57.5±4.7	58.4±5.0	58.9±5.6
Rhode Island Red	86 to 131	56.6±4.0	60.0±4.3	61.9±5.2	62.6±5.1
Blue	123 to 124	52.3±3.5	56.1±3.7	-	-
Black	126 to 138	52.5±3.3	57.2±3.9	-	-
Burgundy	80 to 140	55.0±4.2	59.0±4.7	61.0±5.1	62.2±5.2

chimeras from cyropreserved gonadal primordial germ cells (Tajima *et al*., 1998; Song *et al.* 2005) requires approximately 10 pairs of gonads to generate one germline chimera. Three hundred pairs of Stage 27 gonads from each of the six lines representing 90 individual birds per line were cryopreserved (Tajima *et al*., 1998), which should allow recovery of 30 individual birds by production of germline chimeras if needed.

A surgical technique for orthotopic transplantation of ovarian tissue in newly hatched chickens has been developed (Song and Silversides, 2006) and used to produce donor-derived offspring from the host hens (Song and Silversides, 2007). This provides an alternative approach for cryopreserving avian female germplasm, and research is underway to evaluate the efficiency of using cryopreserved ovaries to give rise to donor-derived offspring. Once this has been demonstrated, ovaries from newly hatched chicks from each of six lines will be stored in liquid nitrogen.

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Status and conservation of Mewari and Jaisalmeri camels in India

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Summary

The Mewari and Jaisalmeri breeds of camel are among the four major breeds of Indian camel. The Mewari breed is known for the production of milk and its adaptability to the hilly terrain of the Aravali hills in south Rajasthan whereas the Jaisalmeri breed is known for its riding and race potential. A total of 320 camels from 16 herds in eight villages belonging to three districts of the major breeding tract of the Mewari camel were covered. The population of the Mewari camel was estimated to be 16 221 heads with a 28% decline in the last five years. The extent of cross breeding was estimated to be 36%. The average adult Mewari camel had a 193 cm height at wither, 194 cm heart girth and 158 cm body length. Adult Mewari camels produce about 700 grams of hair per annum and the females produce 5-7 litres of milk per day. An integrated rotational grazing pasture development programme could be of great use in maintaining the Mewari camels with diverse livestock species under optimum production.

To define the status of the Jaisalmeri camel, an investigation encompassing 1 760 camel breeders belonging to the 181 villages distributed over the entire strata of the tract was carried out. The population of the Jaisalmeri camel was estimated to be 118 083 heads with a 31% decline in the last five years. An adult Jaisalmeri camel had a 199 cm height at wither, 211 cm heart girth and 156 cm body length. Adult males and females weighed 593 and 519 kg, respectively. Emphasis should be placed on making the breedable males of the breed available throughout the strata and on improving the utility of the breed for *in-situ* maintenance of genetic diversity in the breed.

Resumen

Las razas de camello Mewari y Jaisalmeri se encuentran entre las cuatro más importantes de la India. La raza Mewari es conocida por su producción de leche y su capacidad de adaptación a las zonas de colina de Aravali en el sur de Rajastán. Aquí, la raza Jaisalmeri es conocida por su potencial en carreras. Se han estudiado 320 camellos provenientes de 16 rebaños en ocho poblados de entre los tres distritos de mayor población de esta raza Mewari. La población de Mewari se ha estimado en 16.221 cabezas con un declive del 28% en los pasados cinco años. El impacto de cruces se ha estimado en un 36%. Un camello adulto Mewari posee una altura de 193 cm, 194 cm de circunferencia torácica y 158 cm de largura corporal. Un camello adulto Mewari produce 700 g de pelo por año y las hembras producen 5-7 litros de leche por día. Un programa de desarrollo de pastos integrados en rotación podría ser de gran interés para mantener los camellos Mewari dentro de rebaños de diversas especies con un óptimo de producción.

Para establecer la situación del camello Jaisalmeri se ha llevado a cabo una investigación con 1 760 ganaderos pertenecientes a 181 poblados distribuidos por toda la zona de origen. La población de Jaisalmeri se ha estimado en 118 083 cabezas con un declive del 31% en los pasados cinco años. Un camello adulto de Jaisalmeri mide 199 cm de altura, 211 cm de circunferencia torácica y 156 cm de longitud corporal. Los machos y hembras adultos pesan 593 y 519 kg, respectivamente. Es importante que los machos reproductores de la raza estén disponibles y mejorar su utilidad *in-situ* manteniendo la diversidad genética de la raza.

Keywords: *Camel, Mewari, Jaisalmeri, Mewati, Characterization, Conservation.*

Introduction

The camel, the beast of burden in the desert, has diversified uses ranging from its primary use as a draught animal to sports, national security and the production of commodities like hair, milk and meat. Despite its potential to thrive well on meager resources under extreme climatic conditions, the

population of camels is decreasing at a significant rate. The world has 19.3 million camels. Somalia is the country with the highest population of 6.2 million camels (Somali Livestock Statistics, 1989) followed by Sudan with 3.3 million, Mauritania with 1.3 million, Kenya with 0.83 million, Pakistan with 0.8 million and Chad with 0.74 million. India ranks seventh with a population of about 0.635 million camels (FAOSTAT data, 2005).

The camel population in India was around 0.60 million in 1951 and increased until 1972 with an annual population growth ranging from + 2% to + 6%. It remained static until 1977 followed by a period of marginal increase-decrease ranging from + 0.6 to - 0.4% until 1992 and an annual decrease of 2% and 6% respectively in the livestock census carried out in the years 1997 and 2003. The country has four major breeds of camel; the Bikaneri, Jaisalmeri, Kachchhi and Mewari. (Kaura, 1961; Rathore, 1986 and Report of the Camel Development Committee, 1988). The status and conservation of the Mewari and Jaisalmeri breeds are discussed below.

The Mewari breed of camel is adapted to the hilly terrain of the Aravali hills of Mewar in south Rajasthan which is considered to be the major breeding tract of the breed (Rathore, 1986; Kohler-Rollefson, 1992 and Khanna, 2004). This breed has also spread to the adjoining areas of Madhya Pradesh and Gujarat (Rathore, 1986). It has also been referred to as a mountain type or hill camel in the literature (Leese, 1927), being a breed which could climb the hills and thrive on the trees that grow in the hills and withstand more rains than other camels (Rathore, 1986). Camels in most of the adverse geographical locations acted as a multipurpose animal where males were used for draught and transport, females for milk and both sexes for meat (Wilson, 1984 and 1997). The present scenario however, shows milk production as the chief reason for its use in the Mewar area.

Mewari camels have strong hindquarters, heavy legs and hard, thick foot pads. Their body hairs are coarse, and protect the animals from the bites and stings of wild bees and insects. The head is heavy, set on a thick neck. Mewari camels do not have a well marked depression above the eyes (*stop*), but their muzzles are loose. The ears are thick and short, set well apart, and the tail is long and thick (Rathore, 1986).

Jaisalmeri camels are predominantly bred in Jaisalmer, Barmer and part of the Jodhpur district of Rajasthan state and are well known for their riding and race potential (Rathore, 1986 and Rai *et al*., 1992). The camel type in the breeding tract has been termed Pangal and the opportunity to ride a Pangal was considered as an important criterion in achieving contentment in life (Rathore,1986). Leese (1927) and Kaura (1961) grouped the Jaisalmeri (Jessulmere) camels under the category of Desert Type camels along with the Bikaneri camels. Rollefson (1992) was able to trace the royal family sponsored breeding of Jaisalmeri camels by the Maharajas of Jaisalmer, and their relatives in Nachna village.

The quinquennial livestock census data for camel are available for the years 1951 to 2003 and show a severe decline in the camel population in the last ten years. However, no efforts were made to enumerate the populations of camel breeds. Therefore, it was decided to investigate the present status of the Mewari and Jaisalmeri breeds of camel in their breeding tracts and suggest suitable strategies for the maintenance of adequate genetic variation in the populations for optimum utilization of their production potential before they are classified as threatened breeds.

Materials and Methods

For Mewari camels, the study was conducted in the Udaipur, Rajsamand, Chittorgarh, Alwar and Bharatpur districts of Rajasthan, the Banaskantha district of Gujarat, the Neemuch district of Madhya Pradesh and the Agra and Mathura districts of Uttar Pradesh. Since camels in this area are reared by a particular community termed '*Rebari*', three villages of Rebaris in Udaipur district, two villages in Rajsamand district and three villages in Chittorgarh district, having some sizable camel populations, were selected for the investigation. In all, 320 camels from 16 herds in eight villages belonging to five tehsils (blocks) of three districts were covered (Table 1). Individual animals of each herd were meticulously judged for the typical features of the breed according to the described breed characteristics (Rathore, 1986). Body measurements for seventeen body parameters were recorded for 57 adult camels. Production and economic aspects were discussed with individual camel herd owners (n = 16) and some other resource persons (n = 6).

The camel population data (Livestock Census, 2003) was utilized to extrapolate the figures for the availability of breedable males and females, as well as total Mewari camels by percentage at district level. The population of Mewari camels and breedable males and females in the adjacent

Madhya Pradesh was extrapolated using the proportions of Chittorgarh district which is quite similar in topography and geographically adjacent to Madhya Pradesh throughout its eastern border. Male camels of less than 5 years of age (Khanna *et al*., 1993) and female camels of less than 4 years of age (Khanna *et al*., 1990) were classified as breedable.

As for the Jaisalmeri camel, the whole breeding tract was divided into 10 strata for the purposes of characterisation and the preparation of conservation strategies. The Jaisalmer and Barmer districts were divided into four strata each and the Jodhpur district into two strata. Thirty field centres were opened, of which nine were in Jaisalmer district, 16 in Barmer district and five in the Jodhpur district. In all 1760 camel keepers gave relevant information for the investigation, of which 627, 1 034 and 99 were from Jaisalmer, Barmer and Jodhpur district respectively. A total of 181 villages were covered, of which 65, 85 and 31 were from the eleven tehsils (blocks) of the Jaisalmer, Barmer and Jodhpur district respectively. For *in-situ* characterization of the breed, physical characteristics and biometry of 2 918 adult camels was measured. Since the weighing of the camels was not feasible in the tract itself and the Mewari breed is not maintained at any organized farm in this country, the body weight data recorded at the National Research Centre on Camels, Bikaner, India for the Jaisalmeri breed were analyzed for the period 1977 to 2005. Due to similar reasons the exact reproductive performance data belonging to the Centre were analyzed for Jaisalmeri breed for last eight years.

This investigation was carried out during the period 2001-2004. The population figures were extrapolated at the district level and pooled for estimating total population of the breed in the habitat. The latest livestock census conducted by the government of India during the year 2003 was taken as the basis of extrapolation of the population figures.

Results

Habitat and distribution

The breeding tract of Mewari camel consists of the hills of the Aravali in the Mewar area. The major breeding tract of the breed encompasses the Udaipur, Chittorgarh, and Rajsamand districts and the adjoining Neemuch and Mandsour districts of Madhya Pradesh in India. The adjoining Banaskantha district of Gujarat was also surveyed but the camels found there now were more of Kachchhi x Bikaneri type than Mewari. The camel population present in the Mewat area represented a different picture which is discussed separately. However, the major breeding tract extends east from 73°02′ to 75°92′ longitude and north from 23°30′ to 25°46′ latitude with fairly good vegetation and rainfall. Average height from main sea level is about 575 metres.

The breeding tract of the Jaisalmeri breed encompasses the Jaisalmer, and Barmer districts and part of the Jodhpur district in Rajasthan, India (Figure 1). The breeding tract extends east from 69°30′ to 73°04′ longitude north from 24°37′ to 28°15′ latitude. The average altitude of the tract

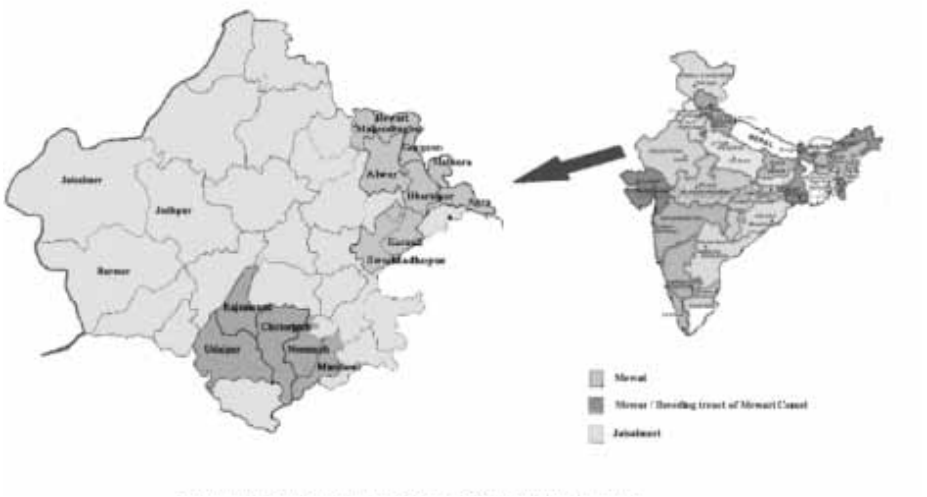

Figure 1. Breeding tract of Mewari and Jaisalmeri camels.

from main sea level is about 250 metres. Sand dunes are the typical features of the tract. A few open wells (Figure 2), tube wells and branches of the Indira Gandhi Canal are the three chief sources of drinking water for the livestock in the breeding tract.

Physical features

Physical features are the primary indicators for an individual to be classified in a particular breeding group. The Mewari breed of camel has been described very briefly in the literature. Kaura (1961) described the hill camels of North Punjab. The features described by the author match the description of the Mewari camel. Rathore (1986) described the development of the Mewari camel from the hill camels of old Punjab state, thus the findings are commensurate with one another. Kohler-Rollefson (1992) briefly discussed the Mewari camels and could not trace evidence of royal family sponsored breeding in the ancient literature. However, the exhaustive listing of physical features and analysis of the extent of variation exhibited by the camels of the Mewari breed within each phenotypic class was largely lacking. Henceforth, the physical features along with body measurements for seventeen parameters for the two sexes were recorded (Figure 3 to 5). The body colour in Mewari camels generally varies from light brown to dark brown but some animals are almost white (Figure 6), such variation in body colour is generally not seen in other breeds of camel. The milk vein is prominent and the udder is well developed in females. The physical features have been summarized in table 2.

The Jaisalmeri camels are gracious, lightly built, slightly lean and thin in appearance. They are of active temperament and are quite tall with long, thin legs. They have a small head and mouth with a narrow muzzle. The head is well carried on a thin neck and the eyes are prominent. The forehead is not dome shaped and is without any depression above eyes (stop). Also, there is no luxuriant growth of hairs on their eyebrows, eyelids and ears. The body colour is predominantly light brown. The Jaisalmeri camels have thin skin and short hairs on their body. The udder is mostly round in shape (Table 2 and Figures 7 and 8).

Figure 2. Open well in the breeding tract.

Table 1. Composition of camel herds in the breeding tract of Mewari camel.

Districts	*Tehsils* (Blocks)	Villages	Resource persons	Herds	Total camels	Mewari		
						Total camels	Breedable males	Breedable females
Udaipur	Girva	2	8	5	89	49	1	29
	Kurabad	1	1	1	9	9	2	4
Rajsamand	Nathdwara	2	7	5	61	61	7	27
Chittorgarh	Chittorgarh	1	3	2	141	70	0	30
	Bhadesar	2	3	3	20	20	3	10
Total	5	8	22	16	320	209	13	100

Body parameters

Apart from characterizing a breed, body parameters have their own importance. The body length, height at wither and heart girth have been shown to be positively correlated with the draught potential of the camel (Annual Report: 1990-1991, National Research Centre on Camel, Bikaner) whereas the size of the hump is more related to the nutritional status of the camels. Long and thin legs indicate better racing potential (Khanna and Rai, 1989). Long tails have been designated as a tool for protection from wild honey bees (Rathore, 1986). Henceforth, seventeen body parameters of Mewari and Jaisalmeri camels were measured and their average values were calculated. An adult Mewari camel had a height up to wither of 193 cm, a heart girth of 194 cm, a body length of 158 cm, a tail length of 58 cm, a neck length of 107 cm, a distance between the eyes of 18 cm, an ear length of 12 cm, a distance between the ears of 19 cm, a face length of 45 cm, a hump circumference hump (horizontal/vertical) 103/51 cm, a fore leg length of 144 cm, a hind leg length of 154 cm, a fore leg foot pad (length/width) of 20/22 cm and a hind leg foot pad (length/width) of 18/19 cm. On the other hand, an adult Jaisalmeri camel had height up to wither of 199 cm, a heart girth of 211cm, a body length of 156 cm, a tail length of 55 cm, a neck length of 109 cm, a distance between the eyes of 22 cm, an ear length of 12 cm, a distance between the ears of 19 cm, a face length of 53 cm, a hump circumference (H/V) of 100/ 45 cm, a fore leg length of 146 cm, a hind leg length of 154 cm, a fore leg foot pad (length/width) of 19/19 cm and a hind leg foot pad (length/width) of 17/17 cm.

Growth

The Jaisalmeri camels are lighter than the Bikaneri camels as the camels of this breed were used for long distance travel and accordingly selection for this type of build might have been done (Rathore, 1986). The average body weight in males and females was 37 and 37, 212 and 211, 277 and 278, 359 and 339, 423 and 391 and 490 and 442 kg respectively at birth, 12 , 24, 36, 48 and 60 months of age. An adult male weighed on average 593 kg and an adult female 519 kg. Analysis of growth data indicated that up to 24 months of age the superiority of the males over females fluctuated but after 24 months of age the males were consistently heavier than the females. However, the effect of sex was non significant ($P>0.05$) up to 36 months of age and thereafter it was significant ($P<0.05$) at 48 and 60 months weight and highly significant ($P<0.01$) in adult weights.

Production, Reproduction and Health Aspects

Milk production

Female Mewari camels maintained on free grazing land without any supplementary feeding give 5-7 litres of milk per day. The lactation length is 14-16 months. According to present investigation, about 8 000 quintals of camel milk is being sold daily at Rs. 6-10 (1 INR = 0.0224517 US$) per kg for human consumption in Udaipur and adjoining cities, such as Chittorgarh, Nimbahera, Neemuch, Ratlam, Jawara, Mandsour etc. The chief use of this milk is in the preparation of tea and coffee.

The females of the Jaisalmeri breed are poor in milk production. The average daily milk production was highest in two teat stripping (3.72±0.17 kg) followed by four teat stripping (2.17±0.16 kg) and machine milking (2.02±0.19 kg). The lactation length can continue up to 14 –16 months. The milk production data indicated an increasing trend up to

Table 2. Physical features of Mewari and Jaisalmeri camels.

Physical characteristics	Mewari		Jaisalmeri	
	Male	Female	Male	Female
1. Body color				
a. Very Light brown (%)	7	7	3	1
b. Light Brown (%)	43	44	54	55
c. Deep Brown (%)	50	49	43	44
2. Hair on ears and eye lid (Jheepra)				
a. Absent	Yes	Yes	Yes	Yes
b. Present	No	No	No	No
3. Head				
I. Size				
a. Small (%)	54	20	19	16
b. Medium (%)	43	77	70	77
c. Large (%)	3	3	11	7
II. Well marked depression above the eyes(*stop*)				
a. Absent	Yes	Yes	Yes	Yes
b. Present	No	No	No	No
III. Fore head				
a. Normal	Yes	Yes	Yes	Yes
b. Prominent	No	No	No	No
IV. Supra-orbital fossa				
a. Deep	No	No	No	No
b. Normal	Yes	Yes	Yes	Yes
V. Muzzle				
a. Type	Loose	Loose	Narrow	Narrow
b. Lips	Droopy	Droopy	Normal	Normal
4. Body size				
a. Small (%)	61	24	8	6
b. Medium (%)	25	56	81	86
c. Large (%)	14	20	11	8
5. Hump size				
a. Small (%)	71	41	15	13
b. Medium (%)	29	46	72	82
c. Large (%)	0	13	13	5
6. Udder				
a. Round (%)	-	97	-	98
b. Pendulous (%)	-	3	-	2
7. Milk vein				
a. Small (%)	-	0	-	10
b. Medium (%)	-	32	-	81
c. Large (%)	-	68	-	9
8. Temperament				
a. Active (%)	91	88	91	88
b .Dull(%)	9	12	9	12

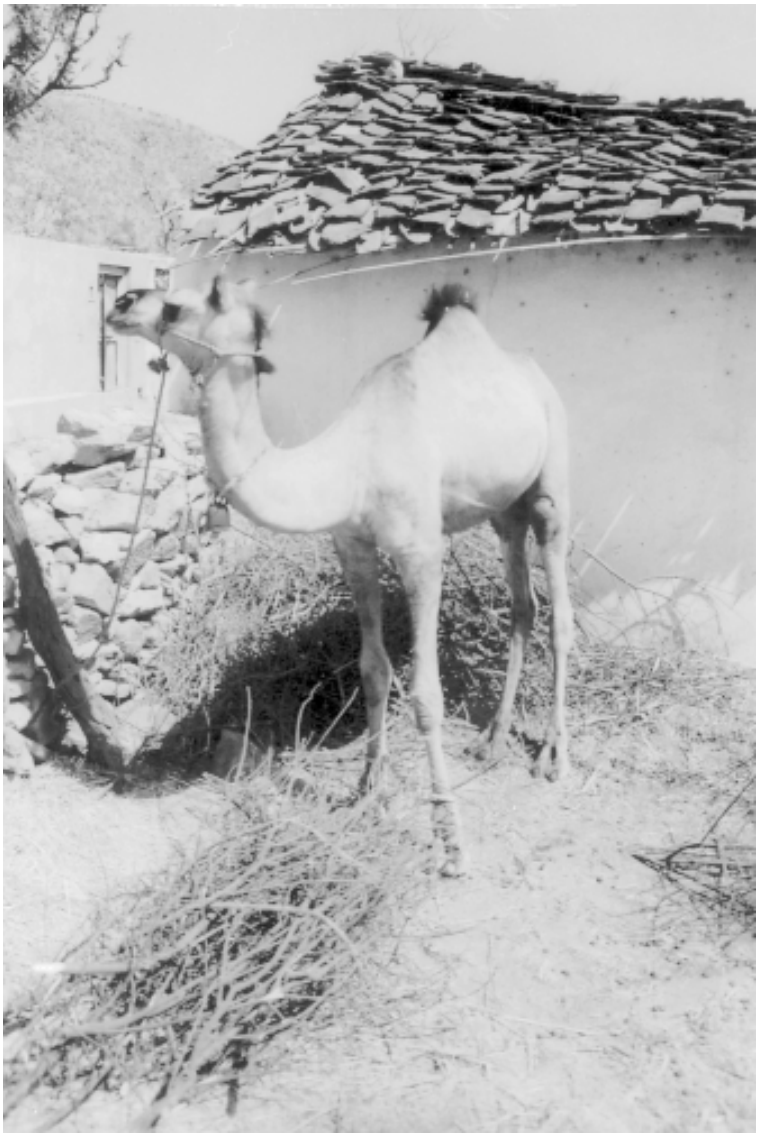

Figure 3. Mewari male adolescent.

the sixth month of lactation and thereafter a decreasing trend. Morning production was 10-27% higher than that in the evening and production from rear teats was significantly higher than that of front teats (Sahani *et al.*, 1998).

Draught

Mewari camels have a multipurpose utility but camels of this breed are mainly classified as milk animals and baggage type. Both males and females can climb with loads on hilly and stony land. Males are good baggage animals on hard land. Camel carts in this area are generally confined to transportation in the mining area. The transportation of bricks and other raw materials over a short distance is done to a very limited extent.

The efficiency of Jaisalmeri camels in racing has been judged to be better than Bikaneri and Kachchhi breeds of camel on the basis of duration of strides, strides per second and speeds at trot and gallop (Rai *et al.*,1992). The Jaisalmeri camels at 20% of their body weight as draught (111±5 kg) work for a period of 58±1.7 minutes, cover a distance of 3.30±0.00 km before exhaustion and generate 1.46±0.10 horse power (Annual Report: 1990-1991, National Research Centre on Camel, Bikaner). A good number of camel carts are being used throughout the breeding tract for transportation of various goods (grains, fuel wood, fodder, construction materials, water, LPG cylinders, etc.) and a camel owner earns on an average Rs. 150 to 200 per day depending upon the location.

Safari

Camel safaris are not a feature of the breeding tract of Mewari camels. However, one or two camels may be available near some historic monuments for short rides by children and tourists. In contrast to the above, it is a very important feature of the Jaisalmeri breeding tract. The camels of this breed are preferred for safari. A good number of safari operators are found in Jaisalmer, Jodhpur, Bikaner and other cities. They organize safaris for a distance of 80 to 300 km (variable) depending on the availability of tourists and time. About 15-30 (variable) tourists are sent at a time for such tours. About 300 camels (variable) in each city are being used for this purpose. A camel owner earns Rs. 100-300 per day depending upon the availability of tourists. Apart from this, the individual camel owners are making a good number of camels available for short rides at various locations in the breeding tract. The famous sand dunes of *Sam* and *Khudi* are located in this tract, where about 50-100 camels are generally available at any time for such rides.

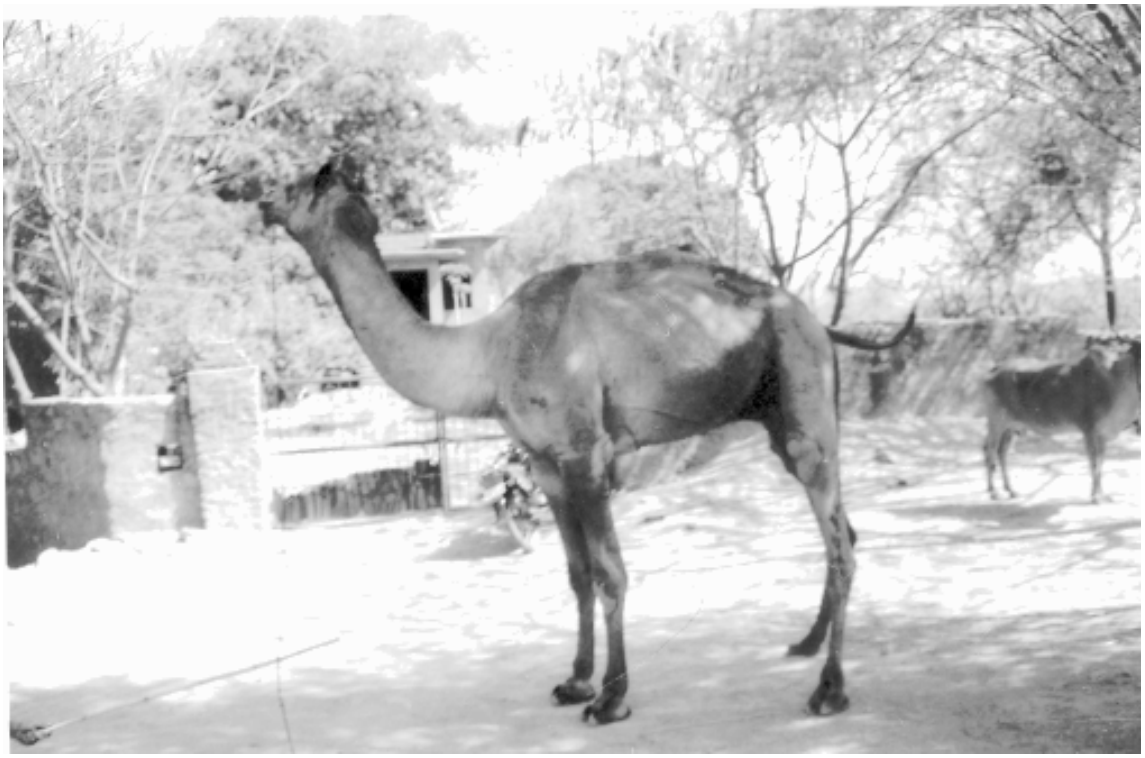

Figure 4. Adult Mewari male.

Figure 5. Adult Mewari female.

Figure 6. Mewari calf.

Hair production and quality

An indirect source of income to the breeder is camel hair. Adult Mewari camels produce about 700 grams of hair per annum. Fine quality hair from camel calves is utilized for blankets whereas coarse quality adult hair is used for carpets. Some weavers in the towns of Rajsamand and Jawara in the Mewari breeding tract are engaged in the production of carpets and blankets but this is not their full time occupation (Figure 9). The charge for yarn production is Rs.15 per kg and for carpets and blankets Rs. 40 per kg. These carpets and blankets are very cheap and durable. The life of a carpet is approximately 50 years and that of a blanket 15 years. Camel hairs are also used in making ropes, which are subsequently used for tying the animals and in making cots.

The annual hair production of adult Jaisalmeri camels has been recorded as 0.733±0.016 kg (Bhakat *et al*., 2003). The analysis of hair quality attributes of Jaisalmeri camels indicated a 6.16±0.24 cm staple length, 35.52±0.59 µ hair diameter and the percentage composition of different types of hair was revealed to be 36.31±0.71% pure, 38.41±0.60% hetero, 36.31±0.71% hairy and 1.25±0.18% kemp fibres (Bhakat *et al*., 2001). Calf hair is superior in terms of hair diameter and the presence of pure type hairs with minimum kemps. Camel hair is being used in village cottage industry by the camel keepers and weavers for the production of blankets, ropes, carpets and other items of daily use.

Reproduction

The observations on the reproductive efficiency of the Mewari and Jaisalmeri camels indicated that the females show the symptoms of puberty at an age of 4 to 4.5 years and first successful conception takes place at an age of 4.5 to 5 years. The gestation length is 13 months. The males exhibit the symptoms of rut at an age of 5.5 to 6 years and can be used for regular breeding at the age of 6 to 6.5 years. The analysis of Centre's data revealed that the average age at first calving, calving interval and gestation length in Jaisalmeri females was 2 089±70.8, 740±11.8 and 390 ± 1.0 days respectively.

Health

The major clinical problem identified by the camel owners of the Mewari breeding tract was that of trypanosomiasis. Almost all camel keepers favour prophylactic treatment of this disease. Mange was second cause of worry to the camel breeders. Indigestion, ectoparasitic infestation, diarrhoea and

pneumonia were the other health problems associated with camels in the tract. On the other hand, mange was the major health problem identified by the camel keepers in the breeding tract of the Jaisalmeri camel. Digestive disorders were the second cause of worry. The digestive disorders included tympany, constipation, diarrhoea, abdominal pain and gastrointestinal obstruction. Trypanosomiasis and reproductive diseases were the next most prevalent. Other health problems included wounds and abrasions, saddle gall, cataracts, kumari (neuromuscular weakness of the hind legs), pneumonia, lameness, pica, ectoparasites excluding mange, tumours and poisoning. In the Jaisalmeri breeding tract about 52% camel keepers favour local treatments followed by allopathic treatment (41%) and herbal treatment (7%). The choice of line of treatment was observed to depend on the nature and severity of the disease and economic status of the farmer (Mehta, 2004).

Status in the breeding tracts

The population of Mewari camels in its natural habitat was estimated to be 16 221 heads with 950 breedable males and 7 874 breedable females and a ratio of 1:8.3 (Table 3). The total population of camels in the breeding tract was 25 473 (Livestock Census, 2003). The population of males and females of less than 3 years of age was 7 877 and 11 983 with a ratio of 1:1.52. This clearly indicated that there was an apparent availability of 4.45 crossbred studs for every Mewari stud competing to breed with the female population available in the tract. The conservation of the Mewari camel is going to be a difficult task as this biased ratio was easily observable on the ground due to the absence of Mewari studs from 50% of the camel herds covered in the investigation. The herd structure in the tract suggested the availability of 64% Mewari camels with 6% breedable males and 48% breedable females (Figure 10). An average herd consisted of about 20 camels (Table 1). Kohler-Rollefson (1992), while discussing management aspects of camel husbandry under contemporary production systems indicated the smaller size (20-50 head) of the camel herds in the Aravali hills. The extent of crossbreeding in the native tract was estimated to be 36% (Figure 10). This crossbreeding was mainly with the Bikaneri breed. The major source of breeding males for the breeders of Mewari camels was the Pushkar fair which is invariably attended by most of the camel keepers of Rajasthan and the adjoining states. The camel breeders share the experience that the calves sired by Bikaneri males are '*maru*' ('maru' means good-looking) but they face difficulty in climbing and walking across hilly terrains especially during the rainy season (personal discussion with Bagdiram Rebari).

The male to female ratio in the entire breeding tract was 1:1.53 and approximately same ratio (1:1.52) was observed among the males and females of more than 3 years of age. Camels in this region are chiefly maintained for the production of milk and camel slaughter for meat is exceptionally rare in the tract. On the basis of the above facts it could be logically assumed that the ratio among the population of breedable males and females would be 1:1.52. Accordingly for breeding of available breedable Mewari females, 5 180 Mewari studs were required as against the available 950, which amounts to about only 18%. A straight comparison between available males and females of more than 3years of age and the estimated population of breedable males and breedable females revealed that the breedable Mewari females constituted 66% of the females (more than 3 years of age) available in the tract as against the Mewari males which constitited only 12% of the males more than 3 years of age. The above figures clearly indicated that the

Table 3. Population of Mewari camel in the breeding tract.

Breeding tract (districts)	Total camel population[1]	Mewari[2]		
		Camels	Breedable males	Breedable females
Udaipur	9 125	5 400	279	3 072
Rajsamand	3 815	3 815	438	1 689
Chittorgarh	4 533	2 534	84	1 126
Adjoining Madhya Pradesh[1]	8 000	4 472	149	1 987
Total	25 473	16 221	950	7 874

[1]2003 Livestock census figures.
[2]Extrapolated figures (see text).

Figure 7. Adult Jaisalmeri male.

population of crossbreds in the tract would further increase at a much faster rate due to the acute deficiency of available Mewari studs (Figure 11). The livestock census data indicated that there has been 28% decline in the population of camels in the breeding tract of Mewari camels (Livestock Census, 2003). The above statistics show that the population of Mewari camel could reduce significantly due to the cumulative effects of crossbreeding and declining camel population in the country.

The population of the Jaisalmeri camel in the breeding tract was estimated to be 118 083 heads with 32 899 breedable males and 41 349 breedable females. The entire tract had 126 984 camels (Table 4). One very important feature noticed when surveying the camels was that the sex ratio was not very much distorted; it was only slightly in favour of females (1:1.25). In most of the livestock species, very few breedable males are left as compared to the breedable females. In camels this was mainly due to the preference of the camel keepers to use the male camels for almost all sorts of work. Females were not preferred for cart pulling, ploughing etc., however this thinking is also changing and some villagers are now using females for draught work due to their docile nature, especially during the breeding season. A severe reduction in the number of breedable males accounts for the inbreeding but in the Jaisalmeri breed, due to the availability of a

Table 4. Population of Jaisalmeri camel in the breeding tract.

Districts	Total camel population[1]	Jaisalmeri camels		
		Total	Breedable	
			Male	Female
Jaisalmer	36 952	35 129	10 560	11 275
Barmer	69 712	64 835	16 150	25 799
Jodhpur[2]	20 320	18 119	6 189	4 275
Total	126 984	118 083	32 899	41 349

[1]As per Livestock Census 2003.

[2]Part of Jodhpur district.

good number of breedable males, this problem is not likely to play a major role in near future.

The latest livestock census indicated that there has been a decline in the overall camel population. The magnitude of this decline is about 31% in the breeding tract of the Jaisalmeri camel in last five years (Livestock Census, 2003). This decline can be attributed to increased mechanization, a severe reduction in the grazing land and vegetation therein, deforestation and the diversion of more land to agriculture due to the Indira Gandhi Canal etc. There has been about a 5% decline in the permanent pastures and other grazing land available in the last decade in Rajasthan (Statistical Abstract, Rajasthan - 2002). Due to commercialization and population pressures the average herd size of camels reduced to 3.74 camels per herd whereas the range was from 1 to 200 (Table 5). An average herd had 7% crossbred camels. This crossbreeding was mainly with the Bikaneri breed of camel.

On an average about one stud was available in a herd but about 36% camel keepers were not keeping any males of the breed. The majority of them (75%) were keeping only one camel for work but about 5% camel keepers were maintaining more than five camels and not having any breedable males of the breed. This situation can not be considered as conducive to the conservation and propagation of the breed (Alderson,1981; Simak, 1990).

Mewari camels in Mewat area

The Mewat area refers to the Alwar, Bharatpur, Karauli and Sawaimadhopur districts of Rajasthan, the Agra and Mathura districts of Uttar Pradesh

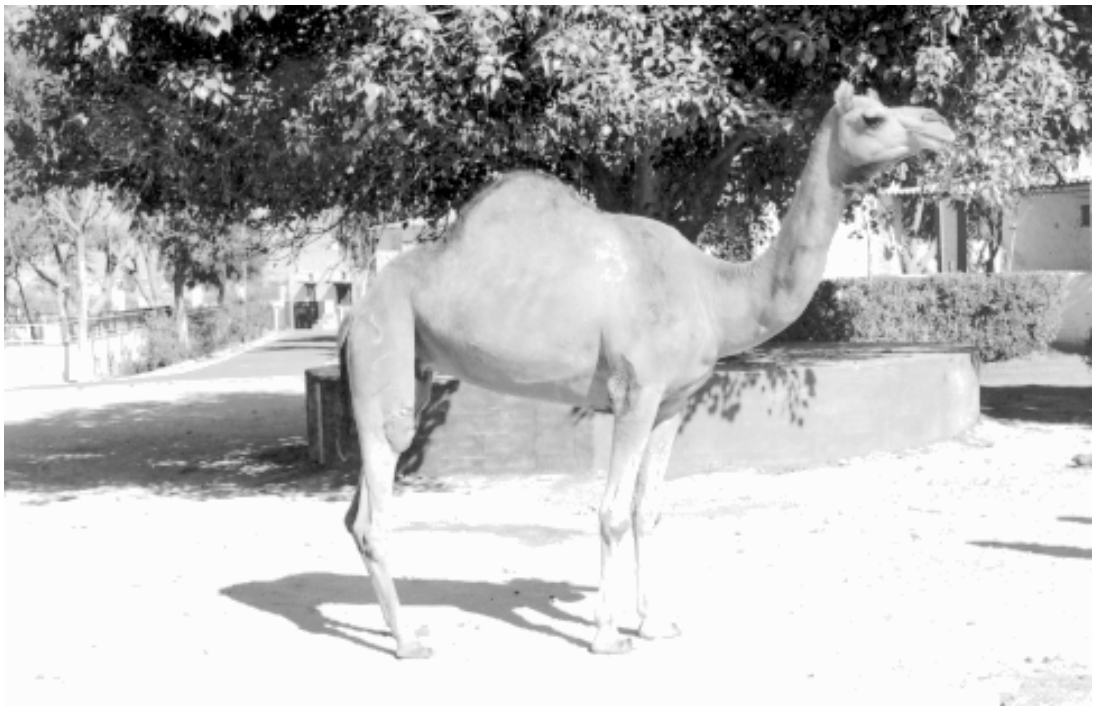

Figure 8. Adult Jaisalmeri female.

Table 5. Availability of breedable males and females of Jaisalmeri breed in a herd.

Districts	Average herd size	Jaisalmeri camels in an average herd		
		Jaisalmeri camels	Breedable	
			Males	Females
Over all	3.74	3.49	0.97	1.23
Jaisalmer	4.20	3.99	1.20	1.28
Barmer	3.19	2.97	0.74	1.18
Jodhpur	6.43	5.74	1.96	1.35

Figure 9. Traditional carpet weavers showing a camel hair and cotton mixed handmade carpet.

and the adjoining areas of the Mahendragarh, Rewari and Gurgaon districts of Haryana. This region also has some camel populations. There were about 30-35 villages of the Rebari caste in the Alwar and Bharatpur districts. The camel breeders have shifted to this area from Mewar due to the availability of dense forest and green vegetation. Rebaris, the traditional camel breeders, in the Mewat area prefer Mewari females as they are good producers of milk and are well adapted to the hilly tracts (Rathore, 1986) whereas the Mev (Muslim) camel users prefer Bikaneri camels because they are engaged in the transportation of goods and the Bikaneri camel has good draught potential (Rai *et al*., 1992). The above observation is commensurate with Leese (1927) who mentioned that the camels found near Agra, Mathura, Delhi, Meerut and other places are from semi-desert areas of Rajasthan and many are crosses between Mewari and Bikaneri camels.

Improvement and conservation

In the breeding tract of the Mewari breed, camel milk was being sold for human consumption much earlier than in the year 1978 when the first case against a vendor selling camel milk was registered in Udaipur. The case ended with the legalization of the sale of camel milk for human consumption by the Supreme Court of India in the year 2000. Still, the setting of standards for camel milk and the inclusion of camel milk in the Dairy Act are awaited (Rollefson, 2004 and Bagdi Ram Raika, 2004). There is a general sense of apathy and neglect regarding the breed. If concrete measures to overcome the existing declining trend in camel populations and the problem of cross breeding in the Mewari tract are not taken, it is likely that the Mewari breed would qualify to be considered as endangered in the not too distant a future.

In view of the long lactation length (Sahani *et al*., 1998) and the increased consumption of camel milk by the human population in the breeding tract (Rollefson, 2004 and Bagdi Ram Raika, 2004) there is a need for improvement in the milk production potential of the camels in this area. The traditional use of camel hair (Figure 9) and present day use of camel skin and bones for the manufacture of gift items should be encouraged to ensure increased utility of the breed and hence the *in-situ* conservation of the breed. An integrated rotational grazing forest or silvi pasture development programme along with a disease control and breed improvement programme could be of great use in maintaining the Mewari camel with diverse livestock species under optimum production conditions.

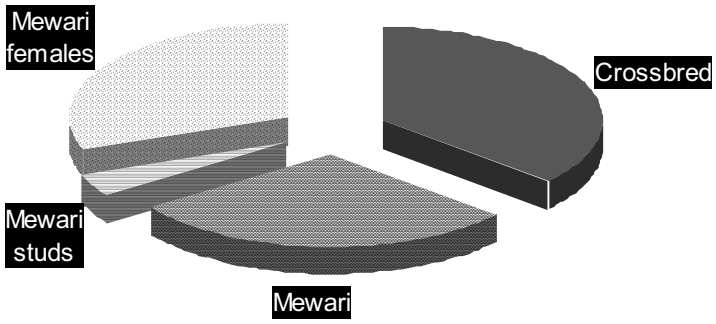

Figure 10. Status of Mewari camel in the breeding tract.

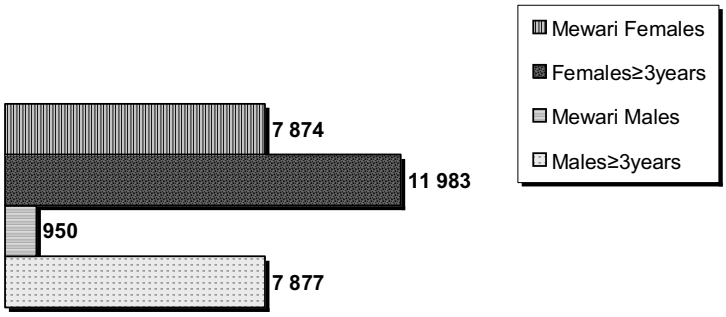

Figure 11 . Breedable population of Mewari camel in the breeding tract.

The Jaisalmeri camels inhabit the Indian part of the Thar desert in Rajasthan state which has about 78% of the camel population of this country. Low fertility of soil, low rainfall and humidity, poor vegetation and scant water resources are the typical features of this tract. Due to the international Indo-Pak border, the road connectivity between important places has improved but there are still several villages, which do not have proper road connectivity. Camels in this part of the country are used for safaris, riding, travel, the transportation of goods, ploughing etc. Due to various reasons discussed earlier, the population of camels in this tract is declining very fast. In the last five years, i.e. from 1997 to 2003, a 31% decline in the population of camels in the breeding tract has been noticed. Further, this rate of decline in the camel population is expected to increase substantially in the near future. The average size of herds has reduced to only 3.74 camels per herd and a good number of herds (5%) did not have a single stud of the Jaisalmeri breed despite the sizable female population. On the other hand, due to a continuous increase in the price of fossil fuel, an increase in pollution, severe consecutive droughts, a reduction in underground water availability etc., the community has been forced to make use of some eco-friendly alternatives i.e. animals in general and the camel in particular in the desert region.

To sustain this breed in its breeding tract *in-situ*, there is a need to ensure improvement, increase the utility of the breed, ensure the availability of elite males for breeding in all strata of the tract, increase public awareness of the need for conservation and encourage the formation of breed societies. Under *ex-situ* situations, the National Research Centre on Camels, Bikaner is maintaining a herd of the breed with elite studs and has cryo-preserved the semen from certified camels of the breed. This Centre is also distributing breedable males through the state government for genetic improvement in the field and providing consultancy services for conservation.

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Utilisation and Conservation of Farm Animal Genetic Resources

Oldenbroek K. (Ed.)
Published by Wageningen Academic Publishers, The Netherlands
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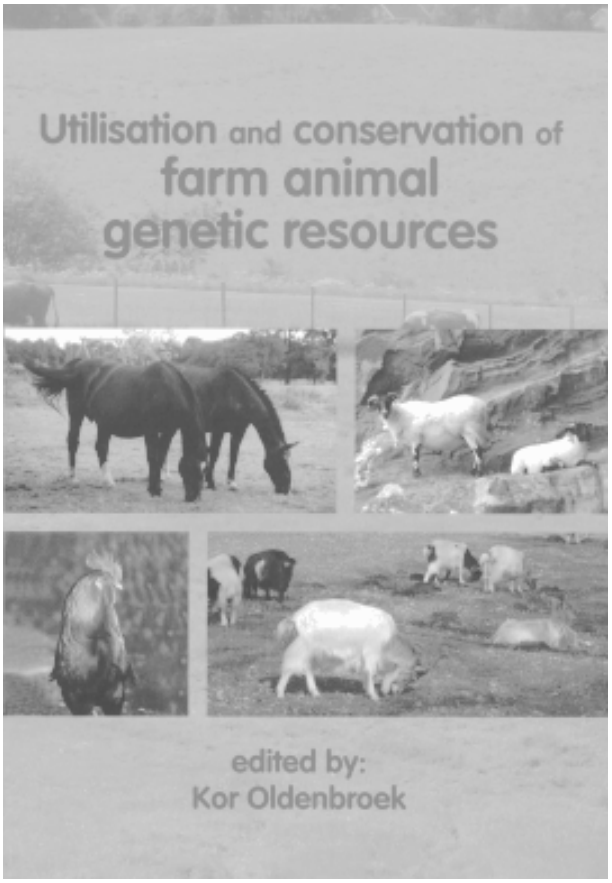
ISBN: 978-90-8686-032-6



The genetic diversity comprised in farm animal species and breeds is an important resource in livestock systems. For several reasons, within the different species used for food production only a few breeds are developed toward high-output breeds fitting in high input systems. In this process many breeds are set aside from the food producing livestock systems. These breeds will be faced with extinction unless new functions for these breeds are found. This is real threat for the genetic diversity within species.

This book is intended to give insight into the issues of the utilisation and conservation of farm animal genetic resources towards a broad group of readers interested in these subjects. The insight is presented as applications of population, molecular and quantitative genetics that can be used to take appropriate decisions in utilisation and conservation programmes. A previous edition of this book is a key resource in courses worldwide and cited in many scientific publications.

The first two chapters present the decisions to be made in utilisation and conservation. Chapter 3 surveys the different ways in which the diversity we observe within a species can be characterised. Chapter 4 illustrates recent results using this theory for utilisation and conservation purposes. Chapters 5, 6 and 7 give theoretical backgrounds necessary to make decisions and chapters 8 and 9 present the operation and practical implications of selection and conservation schemes.

Autochthnous Breeds of Domestic Animals in Serbia and Montenegro

S. Stojanovic & S. Dordevic-Milosevic & G.J. Viljoen (Eds)
Katalogizacija u Publikaciji Narodna Biblioteka Srbije, Beograd
Published in 2003, pp. 250
ISBN: 86-7650-007-X

This soft cover publication summarises the state of the art about the Serbian AnGR, their characterisation and conservation plans undertaken by the national Authorities. The international agreements that define the necessity of animal conservation for global, scientific, practical significance and ethical meanings are summarised before the description of the national breeds.

The book presents cattle, sheep and goats, poultry, geese and duck local breeds. For each breed, clear tables summarise the taxonomy, the breeding tract, essential information about the animal population that reveal very useful for establishing conservation programmes. A brief physical description reported in the tables allow the reader to have a general idea about the aspect of the breeds and clear pictures for each one complete the available information.

Technical and Economic Analysis of the Sheep and Goat Production Systems: Methodology and Appraisal for Development and Prospects

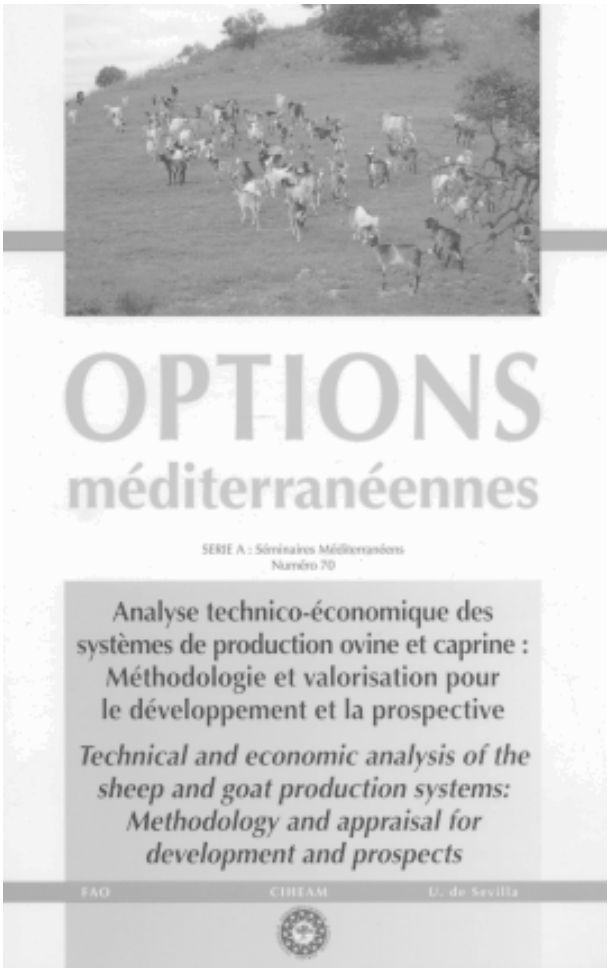
Mena Y., J. Castel & P. Morand-Fehr (Eds)
Options Mediterraneennes Serie A: Séminaires Méditerranéens
Published by CIHEAM, Apdo 202, 50080Zaragoza, Spain
Published in 2006, pp. 232
ISSN: 1016-121-X; ISBN: 2-85352-350-0

The publication groups the paper that were presented at a seminar that was held from 16 to 18 June 2005, within the FAO-CIHEAM interregional network of cooperative research on sheep and goats.

The seminar had a three-fold objective: first, to perform a critical analysis of all the work conducted in Andalusia and, if necessary, try to improve the methodology; then, to broaden the field of evaluation of production systems attempting to incorporate other elements: pasture evaluation, estimation of the systems' sustainability, quality of sheep and goat products; finally, to reflect upon this methodological approach, which is mainly applied to dairy systems under intensive and semi intensive conditions, so that it could also be applied to meat systems and to more extensive systems.

The current issue of Options Méditerranéennes, includes all the work conducted in the seminar and may be considered as the Proceedings, grouping the reports and most of the papers presented in Seville. Amongst the twenty-five articles that make up this document, there are three which report on the activities carried out by the Monitoring Body and two which propose widening the scope of evaluation of the systems. Finally, the other articles present the results from the study of sheep and goat systems in Algeria, Egypt, France, Italy, Lebanon, Morocco, Portugal and Spain, using the Monitoring Body methodology, modifying it, and using other methodology, if needed.

This comprises a wide diversity of data and analysis of specific cases which will improve the information and insight for readers involved in the management of sheep and goat production systems and in decision-making within the framework of agricultural policies.



Options and Strategies for the Conservation of Farm Animal Genetic Resources

Glbson J., S. Gamage, O. Hanotte, L. Iñiguez, J.C. Maillard, B. Rischkowshy; D. Semambo & J. Toll (Eds)

Report of an International Workshop held in Agropolis, Montpellier, France, 7-10 November 2005
Biodiversity International, Via dei Tre Denari 472/a, Rome, Italy
Published in 2006, pp. 53
ISBN-13: 978-92-9043-712-3; ISBN-10: 92-9043-712-X

Farm animals play a crucial part in the livelihood systems and well-being of the poor in the developing world, and thereby in helping to meet the Millennium Development Goals. In addition to food, clothing and other goods, livestock are important for income generation, wealth accumulation, traction and nutrient cycling. Of particular significance is the contribution they make to the livelihoods and wellbeing of smallholders in marginal environments, especially women and children.

The need to reduce the degradation of farm animal genetic resources and establish programmes for their conservation and sustainable use is well recognized. It is embodied in the objectives of the Convention on Biological Diversity and in the development of the Global Strategy for the Management of Farm Animal Genetic Resources, led by the Food and Agriculture Organization of the United Nations (FAO). Noting the need for a greater understanding of the status of farm animal genetic resources and the measures necessary for their conservation and sustainable use worldwide, in 1999 the FAO Commission on Genetic Resources for Food and Agriculture initiated a country-driven process to develop the first Report on the State of the World's Animal Genetic Resources. The Report will be finalized at the First International Technical Conference on Animal Genetic Resources in September 2007, hosted by the Government of Switzerland.

With the aim of assisting the international community in developing a global framework for the conservation of farm animal genetic resources and identifying priorities for action, the System-wide Genetic Resources Programme (SGRP) of the Consultative Group on International Agricultural Research (CGIAR), in association with FAO, AGROPOLIS, France, and the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH, Germany, convened an international workshop on Options and Strategies for the Conservation of Farm Animal Genetic Resources in November 2005, hosted by AGROPOLIS in Montpellier, France. The workshop brought together 63 experts from 28 countries and from the CGIAR centres, FAO, the French scientific community, including the Institut national de la recherche agronomique (INRA) and the Centre de cooperation internationale en recherche agronomique pour le développement (CIRAD), and GTZ.

The workshop findings are presented in this report.

Breeding, Production Recording, Health and the Evaluation of Farm Animals

Kyntäjä J., K. Lampinen, A. Rosati & C. Mosconi
Proceedings of the 35th ICAR Session, held in Kuopio, Finland, 6-10 June, 2006
EAAP Publication No. 121
Wageningen Academic Publishers, The Netherlands
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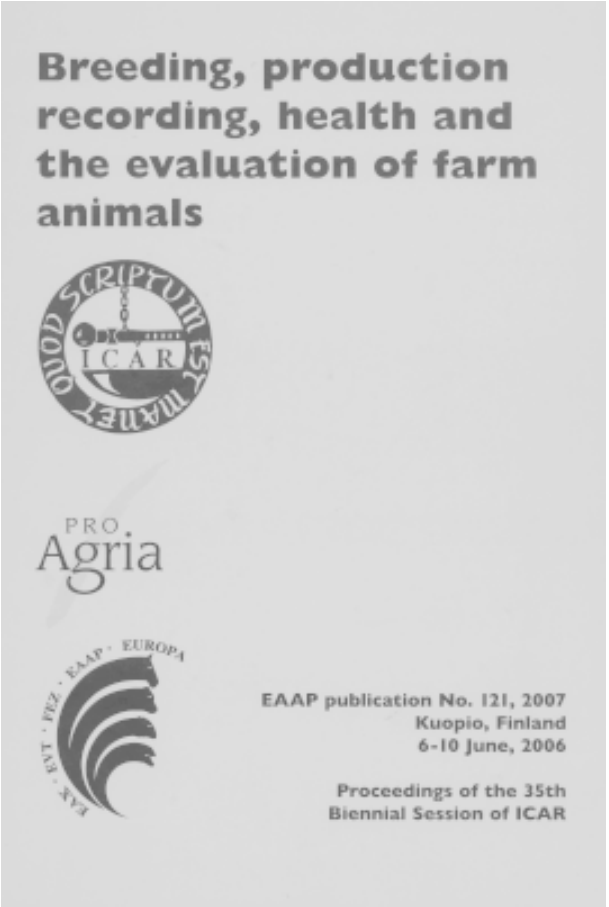
This publication focuses on the various aspects of domestic animal recording, aimed at improving the management of herds and increasing their productivity. New strategies for recording are illustrated and the most updated technologies are presented, on the basis of national experiences where such technologies are already adopted. Although cattle is the prominent species, two parts are dedicated to small ruminants recording and to buffalo recording. Future challenges and opportunities for further development of ICAR and the definition of the future scenarios in the animal recording sector are also described.

A special section is dedicated to «Improving the health traits by recording and evaluation», where the past and future of animal recording and the use of animal recording data for genetic evaluation and breeding are defined.

Another section deals with the "ICAR Reference Laboratory Network", where the reference systems, the principles and the practices for calibration system for routine milk testing are presented.

The publication ends with the national statistics on the "Yearly enquiry on the situation of milk recording in member countries" for the years 2003 and 2004. A total of 45 pages describes the methodologies used at national level for milk recording, the national data for milk production, the costs of recording and the productivity and numbers of recorded cattle at national level (divided by species and by herdbook).



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. 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 indention. 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

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 recommandation 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 desciptions 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 majeur partie des terres consacrées à l'élevage, à la production totale des aliments et l'agriculture provenants 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 compriss 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 évènements nationaux, régionaux et internationaux; ainsi que les conclusions et recommandation par rapport aux objectifs des ces principaux évènements. Les auteurs sont priés d'envoyer ce genre de matériel aux éditeurs.

Guide pour les auteurs

Présentation du manuscript

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 manuscripts se présenteront à double interligne et avec le numéro correspondant à chaque ligne sur la marge gauche. Toutes les pages seront numérotées, y compriss 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 manuscript

Sur la première page du manuscript 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 manuscript en majuscules. Le titre en entier du manuscript 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 nonnlinear models: 1. Estimation of genetic parameters 75, 76-87.
- Dans le cas d'un livre ou d'une publication ad hoc, par example 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 example "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 manuscripts ou correspondence au sujet d'AGRI, vous êtes prié d'utiliser l'adresse suivante:

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 3$1/2''$) 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 escibirá 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 titulo 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

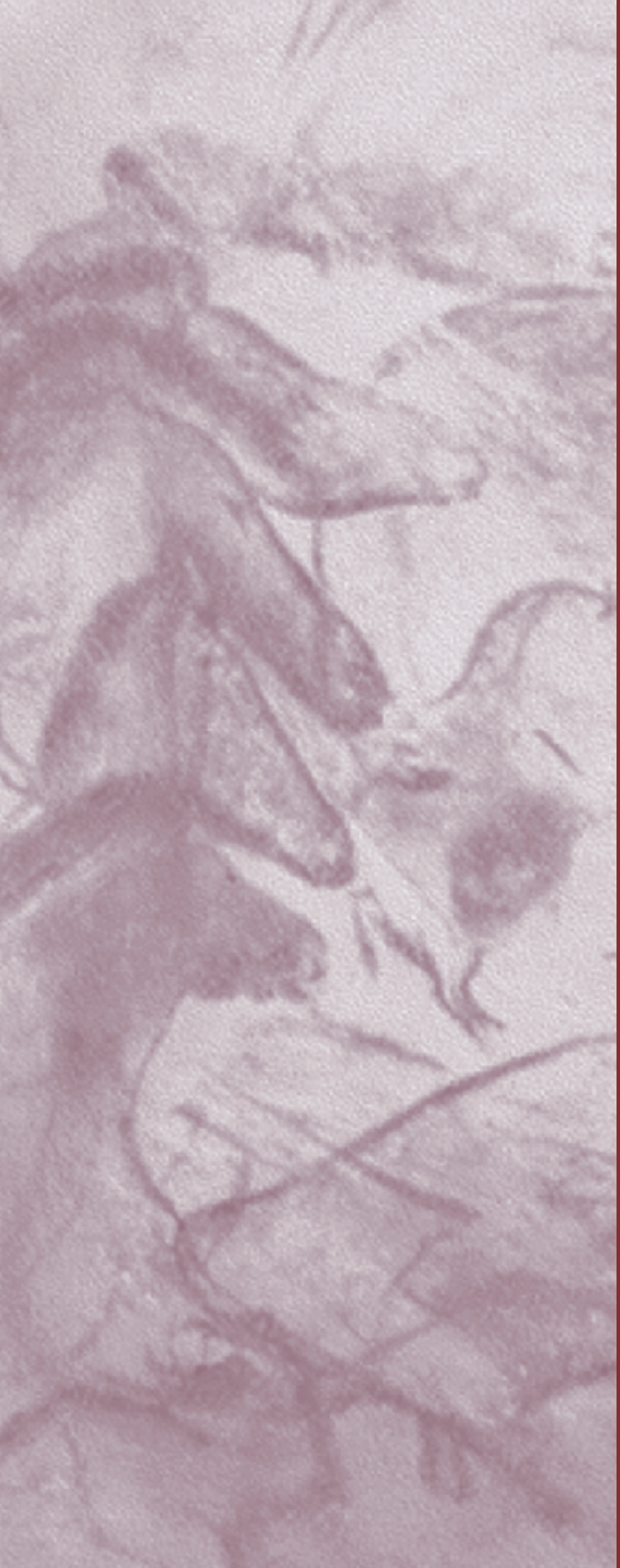
Toda referencia presente en el texto deberá aparecer en la lista de referencias y, de la misma manera, cada referencia de la lista deberá haber sido citada por lo menos una vez en el texto. Las referencias deben ir en orden alfabético del apellido del autor, seguido por el año.

- 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

Gracias por su colaboración



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