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ANIMAL GENETIC RESOURCES INFORMATION

BULLETIN D'INFORMATION SUR LE RESSOURCES GÉNÉTIQUES ANIMALES

BOLETIN DE INFORMACION SOBRE RECURSOS GENETICOS ANIMALES

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Organisation des Nations Unies pour l'alimentation et l'agriculture
Organización de las Naciones Unidas para la Agricultura y la Alimentatción

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Initiative pour la Diversité des Animaux Domestiques
Iniciativa para la Diversidad de los Animales Domésticos

Editors - Editeurs - Editores:
S. Galal & J. Boyazoglu

Viale delle Terme di Caracalla 1, 00100 Rome, Italy

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Editorial
Development of breeding strategies

Livestock breeds are a valuable heritage of humankind. They developed through many generations of both man-made and natural selection. However, man is having increasingly the means to control the environment, he could provide shelter from many environmental factors that affect these breeds, i.e. man has been more able to alleviate the effect of environment. While this has been true in developed countries and in high-input-high-output production systems, it is not generally so in less developed countries and under lower input conditions.

In the former situation a few breeds have been developed during the past six decades that best suite the conditions under this situation while many other breeds declined in numbers and even are facing extinction with the implications of reduced biodivesity and limiting man's ability for sustainable development now and in the future. On the other hand in developing countries and in inherently low input situations little breed development has taken place, and when it has it was for the detriment of the local breeds through rapid replacement and / or indiscriminate crossbreeding in many of the cases. A main reason for this development is the near absence of practical guidelines and methodologies appropriate to the lower animal production systems even though theory is the same for all types of production systems. The question that arises here is can we have breed development at no or minimum loss of local genetic resources in lower input production environments? In other words is it possible to practice conservation through utilisation of local breeds in a way capable of satisfying human needs? Towards that end FAO / AGA and the International Committee for Animal Recording (ICAR) organised a Workshop on Developing Breeding Strategies for Lower Input Production Environments that took place from 22 to 25 September 1999 at Bella Station of Italy's *Istituto Sperimentale per la Zootecnia*, with the support of the Swiss Agency for Development and Cooperation. Preparations for the workshop started by commissioning seminal papers covering the main components in the establishment of breeding strategies, and actual case studies, covering all major livestock species and different parts of the world. The workshop considered the present knowledge and drew lessons from these documentation to develop an integrated set of recommendations for the successful design, implementation and maintenance of animal genetic improvement activities in lower input production systems emphasising the policy, technical and operational needs of developing countries. The results from this workshop will further guide FAO and ICAR in developing decision-support tools to assist member countries, especially the developing ones, in sustainably developing their local breeds. The workshop proceedings will come out early in the year 2000 and be reported on in AGRI 27 in the Recent Publications section

The workshop was attended by 34 participants from 22 countries, beside ICAR and FAO staff. They were scientists, research workers, developers and practitioners in the field of animal breeding. Participation was planned to cover developing and developed countries, most important livestock species and different world regions.

The Editors

Editorial
Développement des stratégies de sélection

Les races domestiques sont un patrimoine de grande valeur pour l'humanité. Elles ont été développées à travers les générations aussi bien par l'homme que par sélection naturelle.

Cependant, l'homme dispose chaque fois plus de moyens pour contrôler l'influence des milieux et peut donc proportioner des refuges contre les différents facteurs environnementaux qui ont une influence sur le développement des races, c'est à dire que l'homme a été suffisament habile pour pouvoir diminuer les effets du milieu. Cette réalité peut être appliquée aux pays développés ou aux systèmes de production avec des *input* et *out-put* élevés, mais beaucoup moins dans le cas des pays en développement ou dans des conditions d'*input* inférieurs. Dans ce cas seulement quelques races bien adaptées aux conditions décrites ont été développées dans les 6 dernières décades, tandis que grand nombre d'autres races ont diminué en nombre et parfois se trouvent même en voie d'extinction, ce qui entraîne une perte de biodiversité et une limitation de la capacité de l'homme pour le développement durable. D'autre part, dans les pays en développement et sous les conditions d'*input* inférieur, il y a eu peu de changements et lorsque c'était le cas il a toujours été au détriment des races locales et à travers une substitution rapide et/ou indiscriminée dans la plupart des cas. Bien que la théorie soit la même pour tous les systèmes de production, il n'existe pratiquement pas de lignes guide pratiques et des méthodologies appropriées pour les petits systèmes de production. La question est si nous pourrons obtenir un développement des races sans, ou avec un minimum, de perte des ressources génétiques locales dans des milieux de production à bas *input*. En d'autres mots, est-il possible de conserver à travers l'utilisation de races locales de façon à satisfaire les besoins des humains?
Tenant compte de tout ceci la FAO (AGA) et le Comité International pour le Contrôle des Performances en Elevage (ICAR) ont organisé un Workshop sur le "Développement de stratégies de sélection pour les milieux de production en conditions difficiles" du 22 au 25 septembre 1999 à Bella (Italie) à l'*Istituto Sperimentale per la Zootecnia*, avec l'appui de l'Agence Suisse pour le Développement et la Coopération. La préparation du Workshop a été introduite par des études de fond suivies par des études de cas actuels représentant les races les plus importantes et couvrant différentes régions du monde. Le Workshop a tenu compte des connaissances actuelles et s'est basé sur cette documentation pour développer un ensemble intégré de recommandations dans le but d'obtenir un dessin, une mise en oeuvre et des propositions de conservation et des activités d'amélioration génétique dans des systèmes de production difficile, tout en soulignant les besoins politiques, techniques et opérationnels des pays en développement.

Les résultats de ce Workshop serviront de guide à la FAO et à l'ICAR pour développer des outils de décision-support qui serviront aux pays membres, surtout ceux en développement, et au développement durable des races locales. La publication des comptes-rendu du Workshop sera prête au début de l'an 2000 et nous en parlerons dans le numéro 27 d'AGRI dans la section Publications Récentes.

Il y a eu 34 participants au Workshop provenants de 22 pays, mis à part le personnel de la FAO et de l'ICAR. Les participants étaient principalement des scientifiques, des chercheurs et des spécialistes dans le domaine de la sélection animale. La participation a été planifier de façon à toucher aussi bien les pays développés que ceux en développement, ainsi que pour couvrir les espèces les plus importantes et différentes régions du monde.

Les Editeurs

Editorial
Desarrollo de estrategias de selección

Las razas domésticas son un patrimonio de gran valor para la humanidad. Han sido desarrolladas a través de las generaciones tanto por medio de la selección artificial como por selección natural.

Sin embargo, el hombre dispone de medios cada vez más eficaces para controlar el medio ambiente, pudiendo proporcionar protección contra muchos de los factores ambientales que afectan a esta razas, siendo por tanto capaz de paliar estos efectos ambientales. Ello ha sido posible en los países desarrollados y en los sistemas de producción intensivos, pero lo ha sido en menor medida en los países en vías de desarrollo y en condiciones de baja intensificación (bajo *input*). En este último caso sólo unas pocas razas, las que mejor se adaptan a las condiciones descritas, se han desarrollado durante las últimas 6 décadas, mientras que muchas otras han disminuido en efectivos e incluso se encuentran en vía de extinción, lo que implica una reducción de la biodiversidad y una limitación de la capacidad del hombre para un desarrollo sostenible. Por otra parte, en los países en vías de desarrollo y en condiciones de bajo *input*, ha habido poco desarrollo en la mejora de las razas y cuando lo ha habido ha sido en detrimento de las razas locales y a través de una sustitución rápida y / o indiscriminada en la mayoría de los casos. Una razón importante para que ésto haya ocurrido es la casi total inexistencia de recomendaciones prácticas y de metodologías apropiadas para los sistemas de bajo *input*, a pesar de que la teoría es, en principio, la misma para todos los sistemas de producción. La cuestión que se plantea aquí es si podemos obtener un desarrollo de las razas sin, o con un mínimo, de pérdida de los recursos genéticos locales en ambientes de producción con bajo *input*. En otras palabras, es posible conservar, a través de su utilización, las razas locales de manera que se satisfagan las necesidades humanas? Con estos objetivos, la FAO (AGA) y el *International Committee for Animal Recording* (ICAR) han organizado, con el apoyo de la Agencia Suiza para el Desarrollo y la Cooperación, un Seminario sobre "Desarrollo de estrategias de mejora genética para sistemas de producción con bajo *input*" que ha tenido lugar en el *Istituto Sperimentale per la Zootecnia* de Bella (Italia) del 22 al 25 de septiembre 1999. La preparación del Seminario se inició encargando unos informes de referencia que consideraran los aspectos principales a tener en cuenta para el establecimiento de las estrategias de mejora, así como una descripción de casos reales, y que representaran las especies ganaderas más importantes así como las distintas regiones del mundo. El Seminario tuvo en consideración los conocimientos actuales y se apoyó en esta documentación para desarrollar un conjunto integrado de recomendaciones para el diseño, implementación y mantenimiento adecuados de las actividades de mejora animal en sistemas de producción de bajo *input*, resaltando las necesidades políticas, técnicas y operacionales de los países en vía de desarrollo. Los resultados de este Seminario servirán de guía a la FAO y al ICAR en el desarrollo de herramientas de ayuda a la decisión para asistir a los países miembros, especialmente aquéllos en vía de desarrollo, para la mejora sostenible de sus razas locales. Las Actas del Seminario serán publicadas a primeros del año 2000 y serán reseñadas en el próximo número 27 de AGRI en la sección Publicaciones Recientes.

Participaron en el Seminario 34 expertos provenientes de 22 países, además de personal de la FAO y del ICAR. Los participantes fueron principalmente científicos, investigadores, extensionistas y técnicos de desarrollo del campo de la mejora animal. La participación fue planificada con el fin de incluir tanto países desarrollados como en vías de desarrollo, así como las especies ganaderas más importantes y las diferentes regiones del mundo.

Los Editores

The state of African cattle genetic resources II. Geographical distribution, characteristics and uses of present-day breeds and strains

J.E.O. Rege & C.L. Tawah

International Livestock Research Institute (ILRI), P.O. Box 5689, ***Addis Ababa****, Ethiopia*

Summary

This paper summarises preliminary results of a survey conducted as part of a large effort to systematically collate information aimed at assessing the status of cattle genetic resources of sub-Saharan Africa. The 146 indigenous breeds / strains identified from the survey are classified into nine broad groups (Humpless Longhorns, Humpless Shorthorns, Large East African Zebu, Small East African Zebu, West African Zebu, Sanga, Zenga, Recently Derived Breeds and Commercial Composites) some of which are further subdivided into several groups (based on possible genetic relationships) and clusters (based on eco-geographical locations). Each breed is then described in terms of location, physical characteristics, adaptive attributes, if known, current main uses and status in terms of qualitative or quantitative indication of trends, where available, and presence or absence of programmes for its management or further development.

Résumé

Cet article présente un résumé des résultats préliminaires d'une enquête conduite au sein d'un programme plus large mené pour recueillir sistématiquement l'information permettant d'évaluer la situation des ressources génétiques des bovins dans l'Afrique Sub-saharienne. Les 146 races / lignes identifiées par l'enquête ont été classées en neuf groupes: sans bosse à longues cornes, sans bosse à courtes cornes, grand zébu de l'Afrique de l'est, petit zébu de l'Afrique de l'est, zébu de l'Afrique de l'ouest, Sanga, Zenga, races dérivées récentes et lignées commerciales. Certains de ces groupes ont été divisé selon leur relation génétique en d'autres groupes, et en sous-groupes suivant le lieu éco-géographique de provenance. Chaque race est donc décrite suivant la situation, les caractéristiques physiques, la capacité d'adaptation, si elle est connue, et l'utilisation principale et la situation du point de vue de la qualité ou quantité selon les indications du marché, si elles sont disponibles, ainsi que la présence ou absence de programmes pour leur gestion ou futur développement.

Key Words: *Breed distribution, Breed characteristics, Bos taurus, Cattle, Derived breeds, Phenotypic diversity, Sub-Saharan Africa, Sanga, Zebu, Zenga.*

Introduction

The background to, and conduct of, the breed survey has been described in paper I of the series (Rege 1999) which also presents the framework for the classification of sub-Saharan African cattle breeds and identifies breeds at risk and those which may have become extinct in the last 100 years. The present paper presents a status analysis of each of the individual breeds and breed groups identified in paper I, taking into account the historical perspective and

available information from the conventional and grey (unpublished) literature, and updating this, to the extent possible, with facts and figures from the local sources. These are presented in terms of physical description, geographical distribution, indication of general trends in population statistics, where available, known adaptive attributes, major uses, indicative performance figures and status of the management of the breed, including genetic improvement. Known and conjectured evolutionary relationships among breeds are also identified, providing bases for hypotheses to be tested in the molecular genetic characterisation. Some of the African cattle breeds are shown in figure 1 to 5.

Humpless Longhorn Cattle of West Africa

This group is represented by only two breeds - the *N'Dama* and the *Kuri.*

N'Dama

The N'Dama's habitat includes the Fouta Djallon plateau in Guinea (original "homeland"); the whole of coastal West and Central Africa – from Senegal through Gambia, to the Democratic Republic of Congo (former Zaire)

The N'Dama continues to play an important role in tsetse-infested regions of West and Central Africa. Increasingly more compelling evidence for its tolerance to trypanosomiasis is serving to promote the breed. Overall population is increasing and geographical range expanding. The current population is estimated at some 4 863 million head.

The N'Dama is compact and set on short legs of fine bone; neck is thick and deep; back is straight from withers to tail head, of good width and well-fleshed. Hind quarters are deep and well muscled. The dewlap and

Figure 1. Skeko cattle breed.

umbilical fold are poorly developed. Coat colour is typically some shade of fawn with darker extremities and lighter underside: Solid colours are most common-light to dark fawn, grey, dun, light red, chestnut, red with black head; belly and lower part of tail may be white. Skin pigment is either red or black. Body size is small, but conformation is that of a beef animal. Oxen make good work animals. Cows are poor milkers: 100 to 475 kg over 150 to 210 day lactation periods have been reported. The breed is the focus of research of many groups in Africa.

Kuri

The Kuri habitat is the shores and islands of Lake Chad. Main location is in southern Chad and northern Nigeria, and smaller populations in northern Cameroon and the N'Guigni province of Niger.

Due to its inability to thrive outside its lake habitat, the Kuri is threatened. Retreating waters of the Lake and consequent reduction in its habitat is a major threat. Resulting rangelands are increasingly populated with zebu cattle, especially neighbouring Arab Shuwa and M'Bororo (Red Fulani), resulting in increased interbreeding. There is also deliberate crossing of Kuri with zebu breeds by Kuri owners to increase milk yield and fertility and by zebu owners in mixed crop-livestock areas to enhance draught power capability. Protracted civil conflict has further worsened the situation in recent past. The Kuri population is estimated at 110 000 head.

Origin, distribution and characteristics of the Kuri are the subjects of a recent review by Tawah *et al.* (1997). Although there are some efforts at characterisation of the breed, there is currently no programme for the management of the Kuri.

Humpless Shorthorn Cattle of West and Central Africa

The present-day distribution of the humpless Shorthorn cattle breeds is restricted to the tsetse-infested areas of West and Central Africa. Indeed, they occupy the same habitat as the N'Dama. There are some 14 breeds / strains of "pure" Shorthorn cattle and five breeds which have been derived from zebu-Shorthorn interbreeding. The pure Shorthorns are of two types: the larger Savanna type predominantly found in the Guinean or Sudano-Guinean savannas from Cote d'Ivoire to Cameroon, and the smaller Dwarf (or Forest) Shorthorns mainly restricted to the coastal forest regions. In French-speaking countries, the Savanna Shorthorns are called Baoulé and the Dwarf type Lagune (and some local synonyms). In English speaking countries the name Muturu is used for Shorthorn cattle. A small population of the Dwarf type found in Cameroon between Buea and Victoria in the South West Province, is known locally as Bakweri, while the Savanna type is represented by Kapsiki, Doayo (synonym Namchi or Poli) and Bakosi.

The status, characteristics and main uses of the humpless Shorthorn cattle breeds have been comprehensively reviewed by Aboagye *et al.* (1994) and Rege *et al.* (1994a; b; c), while their classification has been summarised by Rege (1999). Existing programmes for the management of humpless Shorthorn cattle have been summarised by ILCA (1992).

The Zebu Cattle of Eastern and Southern Africa

The term "East African Zebu" is used to embrace all the "Shorthorn Zebu" of eastern and southern Africa. These populations can broadly be classified on the basis of size and conformation into "large" and "small" types (see Rege, 1999). While the large types predominate the marginal lands of northern Kenya, north-eastern Uganda, northern

Sudan, southern Ethiopia and western Somalia, the small breeds thrive mainly on the high rain-fed lowlands and uplands.

The Large East African Zebu

Boran

The main habitats of the Boran are the Borana plateau of southern Ethiopia, stretching from the Liban Plateau to the extreme southern part of Ethiopia, semi-arid and arid lands of Northern and Rift Valley provinces of Kenya and western Somalia and Jubaland of southern Somalia.

Subtypes or strains of the Boran include: the Somali Boran; the Orma or Tanaland Boran owned by the Orma tribe of the south, and west of the Tana River district of North-Eastern province of Kenya, where they inhabit the tsetse-infested basin of the Tana River; the Kenya Boran also known as Improved Boran which is a result of long-term selection under good management conditions on the commercial ranches in the semi-arid uplands of Rift Valley and Eastern Provinces of Kenya; and the Ethiopian Boran, or Borana of southern Ethiopia.

The Boran is basically a beef animal but is milked by the pastoral communities. Programmes for development of the Boran exist in Kenya, where there is also a breed society, but no such programme exists for strains in the other countries. However, Ethiopia has previously undertaken some on-station evaluation studies.

Karamajong Zebu

This breed inhabits north-eastern Uganda (Jie and Karamajong), south eastern Sudan (*Toposa* strain) and north-western Kenya (*Turkana* strain). The people of Jie, Turkana and Toposa are supposed to have originated from a common tribe as the Karamajong-the Karamajong cluster. The Karamajong zebu are morphologically quite similar to the Boran-large and heavy-boned. No breeding programme exists.

Sudanese Zebu

This is a large group consisting of several breeds belonging to two sub-groups: The *Northern Sudan Zebu* (also known as *Arab Zebu* or *North Sudan Zebu*) and the *Southern Sudan* (or *Nilotic*) *Zebu*.

North Sudan Zebu

This sub-group comprises the *Baggara, Butana* and *Kenana* of Sudan and the *Barka* of Eritrea. The first three are found principally in the grass acacia savanna belt around the irrigated areas and narrow strip of farmland, from Khartoum to the Egyptian border. The Barka inhabits the western lowlands of Eritrea, with a small population being found across the border in Ethiopia.

Kenana

The *Kenana,* the nomadic cattle of northern Sudan, have numerous synonyms related to their tribal (e.g. *Kenana, Rufáai El Hoi* and *Rufáai El Sherik*) and ecological (e.g. *Fung, Gezira* and *White Nile*) origins. They have also been referred to as *Northern Riverain* or *Northern Province* cattle. The traditional habitat of the Kenana is the east of the confluence of the Blue Nile and White Niles at Khartoum and south-east to the Ethiopian border, on the western banks of Blue Nile to the south of Khartoum. The breed is typically more of a dairy than a beef type. It produces some 1 000-5 600 kg of milk of about 5.5% butter fat over a 190-580 day lactation.

Butana

The *Butana* inhabits the Butana plain in central Sudan, an acacia scrub and desert area lying between the Blue Nile and Atbara Rivers. They are referred to as *Dar El Reih* cattle across the White Nile in the northern part of Darfur and Kordofan. Like the Kenana, the Butana is also typically a dairy animal, producing 700-4 600 kg of milk of 4.5% butter fat in a 220-420 day lactation

Figure 2. Horro cattle breed.

period. Both Butana and Kenana have been studied on-station, but no breed improvement programme is in place.

Baggara

The *Baggara* or *Western Baggara* cattle are owned by the Baggara nomadic Arab tribes in the west, central and southern Darfur, central and southern Kordofan and Nuba Mountains, and Suliem Baggara, west of the White Nile. They are typically used for beef, and have been characterised for this purpose in a few studies. No breeding programme exists.

Southern Sudan Zebu

Both *Toposa* (of the Karamajong cluster) and *Murle* cattle predominate in southern Sudan. The former is located in the southern-most part of the country while the latter inhabit the Pibor Post district of the Upper Nile province. Both are owned by the Boya, Murle and Toposa tribes. They are principally used as beef animals. However, there is no breeding programme for any of them.

The Small East African Zebu

These are smaller and more compact animals than the "large" types. They are also more numerous. They thrive in much wetter habitats than the large types and manifest greater variability in size and conformation. However, the two ("large" and "small") types are believed to have common ancestry. Like the Large Zebu group, the breeds / strains or sub-types of the Small Zebu group have tribal and ecological origins. It should, however, be noted that, whereas isolations imposed by tribal boundaries – physical and / or cultural – as well as those due to ecological restrictions are partially responsible for the genetic differentiation leading to different breeds and

strains, the variations in nomenclature associated with tribes and ecology do not in themselves necessarily imply genetic differences. In general, only a small number of breeds / strains in this category have been characterised in any systematic way. Most of them are still in the hands of their traditional owners. There is no breed improvement programme for any of them.

Abyssinian Shorthorned Zebu

The *Abyssinian Shorthorned Zebu* are a mixture of small, thickset and short-horned cattle mainly found in the central highlands of Bale, Harar, Shoa, Sidamo as well as the lowlands of the Ogaden plains in Ethiopia. They are also called *Ethiopian Highland Zebu*. Indeed, the only members of the group which inhabit the lowlands are the *Jijiga Zebu* and the *Ogaden Zebu* which are sometimes referred to as "*Lowland Zebu*".

The *Jem-Jem* or the *Black Highland Cattle* are principally found in the northern parts of Sidamo, in the Bale highlands and surrounding locations of Bale area including Yirga-Alem in Sidamo. They are adapted to the wet and cold highland conditions and are found at altitudes as high as 2 500 metres. They are solid black, black with a white face or white patches on a mainly black background. They are smallish in body, are compact and have slender limbs. They are mainly used as draught animals, but may also be milked. Traditionally only culled animals were slaughtered for meat but increasingly excess adult males are sold off for fattening.

The other Abyssinian zebu strains are distinguishable mainly in relation to the tribes which own them, minor phenotypic differences, habitat, production system and main uses. The *Jijiga* are found in the Jijiga area of Somali Region of Ethiopia in an area adjoining (on the Somali side of the border) the habitat of the *western* strain of the North Somali cattle. The major coat colours are chestnut, black, white or red. It has short horns, the majority of which point sideways or downwards. Their hump is small but prominent. The udder is small to moderate. They are milked routinely.

The *Arsi* cattle inhabit the highlands of Arsi, Bale, Harar, Shoa and Sidamo. They are compact animals with a generally dimiutive length. The dewlap is prominent but thin of skin. The horns are small and short. The coat colour is variable: red, black, roan, white and grey as well as various combinations. They are mainly kept for draught and are poor milkers.

The *Harar* are found in eastern and western Hararghe plateaux. They have short, thick horns and well-developed dewlaps. The common coat colours are black, roan and red. They are used primarily for draught.

The *Bale* are found in the high plateaux of the Bale zone, in areas adjacent to the habitat of the Jem-Jem. They are black, chestnut, white and roan. They have short to medium horns and a prominent hump, and are principally used for draught.

The habitat of the *Smada* cattle is in the area of Lie Gayint, Tach Gayint and Smada in South Gonder, northwestern Ethiopia, an area lying roughly between the bend of Abay River to the south and Mount Guna to the north. They are also found in adjoining areas of Wello. They are mainly black, but other colours and combinations (red, roan, black-and-white) are not uncommon. Horns are short to moderate in length. Humps are small to medium in size. They are mainly used for draught. Although they are milked, yields are quite low.

The *Adwa* are found around Adwa, in the Central Zone of the Tigray Region. They are mainly red, chestnut, black, roan and white and are kept for draught. Milk production is low.

The *Hammer* cattle of Hammer area in South Omo are a variety of the Borana cattle. They supposedly descended from Borana cattle looted from the Borana people hundreds of years ago during a war between the two tribes. Hammer cattle are mainly white or grey, but there are also some chestnut and roan animals. They are of

medium to large build. The horns are short to medium and humps are prominent. They are primarily kept for milk.

The *Mursi* are found in South Omo, in the Mursi area. They are big animals relative to members of the Abyssinian group. The majority have big horns, usually curved inwards – either naturally or through "training". The hump is prominent and well-developed. Coat colour is highly variable, and solid colours are rare. The colour combinations include grey, white, black, chestnut, roan, pied with spots, and striped. The Mursi are mainly kept for milk, but have good "beef conformation".

The *Goffa*, or *Goffa Dwarf*, is probably the smallest strain of the Abyssinian zebu cattle, indeed among all Ethiopian cattle. It is found in Goffa area, principally around Sawla. Humps are small and coat colour is mainly red. Horns are small to medium. Despite their diminutive size, they are used mainly for draught, but are also milked.

The *Guraghe* zebu is found around the Guraghe and Hadiya areas in close proximity to the tsetse-infested valleys of the Ghibe tributaries. They are mainly red, chestnut and roan. Main uses are draught and milk production, but due to the poor pasture conditions and tsetse infestation, they do not perform either function well. The *Ambo* cattle, found in western Shewa around Ambo, Dandi, Addis Alem and Holetta are quite similar to the Guraghe. However, their habitat is much better endowed with grazing. This may be responsible for their apparent larger size, and more "compact-looking appearance" compared to the Guraghe cattle.

Ogaden cattle are a variety of the Borana found in the Ogaden area of the Somalia Region of Ethiopia and bordering Eastern Hararghe. They have a well-developed hump and a large dewlap. Horns are short. They are mainly kept for milk production, but are good beef animals.

The cluster of southern Sudan and vicinity

The *Lugware*, typically short-horned, are found mainly in the region to the west of Aru in the Kibali–Ituri district of north-eastern Democratic Republic of Congo and in the western part of the West Nile district of northern Uganda. They are owned by the Lugwari and Lugbara tribes. Some are also found in the Yei district of southern Sudan. They are phenotypically quite similar to the Mongolla zebu to which they are thought to be related: They are believed to have been brought south from the Sudan two centuries ago.

The *Mongalla* are small, compact animals found in the valleys and lower slopes of the hilly areas around Mongalla and Torit of the eastern part of the Equatoria Province of southern Sudan. They are owned by a number of tribes, mainly of the Nilo-Hamitic origin (the *Didinga*, *Latuka*, *Bari*), hence strains are also named after these tribal groups. They are also known as *Southern Sudan Hill Zebu* and *south-Eastern Hill Zebu*. The Mongalla are rather heterogeneous. The *Bari* strain has extremely long horns and may have Nilotic influence, while the Didinga strain of Didinga Hills and Dongotona Mountains probably carry Toposa blood. Like the Nuba Mountain cattle, the Dongolla have traditionally lived in tsetse "pockets" and may exhibit a degree of tolerance to trypanosomiasis.

The *Nkedi* are found in north-eastern Uganda in the Pallisa, Iganga, Kamuli and Tororo areas. They used to represent the dominant cattle in the Teso district. However, recent cattle raids in the district led to quasi-complete annihilation of the Teso cattle. Consequently, Soroti and Serere districts were restocked with Nkedi cattle from Pallisa and some cattle from Tanzania. The Nkedi are believed to have originated from northern Sudan and have previously been classified with the Mongalla and the Abyssinian Shorthorned Zebu. Ross (1958) identified four strains of Shorthorned Zebu in Teso district, the Serere, Kyoga, Usuk and Karamajong. The Usuk and Kyoga cattle which border the

Karamajong, a "Large Zebu" type, are somewhat larger than the Nkedi and the Serere. Ross (1958) considered that while the Serere was of the Nkedi type, the Kyoga was of the Karamajong type and the Usuk was a fairly recent cross between the Nkedi and the Karamajong, and hence the greater variation. We have classified the Kyoga, Usuk and Serere in a separate group of small zebu, the Teso group.

The *Nuba Mountain Zebu* are extremely small animals, often referred to as 'dwarf' or 'pigmy' cattle. Mainly found in southern Kordofan in Sudan, they are also known as the *Kaolib* cattle. They are phenotypically similar to the dwarf cattle of the Ingessana Hills (Ingessana cattle) and the Mongalla cattle. They also have some similarities, especially with regard to size, with the N'Dama and some West African Shorthorn cattle breeds. Moreover, like the latter, they thrive in tsetse "pockets" and are, thus thought to be tolerant of trypanosomiasis. The Ingessana and Nuba Mountain cattle are steadily decreasing in numbers as a result of indiscriminate crossbreeding with Kenana and Baggara cattle, respectively.

The Somali group

The *Somali Shorthorned Zebu* consists of various strains of small zebu cattle. These include the *Garre*, *Gasara* and *North Somali Zebu*. Mason and Maule (1960) referred to another strain found in Eritrea, the *Bahari* which is quite similar to the North Somali zebu. These are most certainly cattle of the *Arab* or *Baherie* strain. The distribution of the Somali Shorthorned Zebu stretches from Djibouti in the north, along the coast of the Gulf of Aden to Cape Guaradfui and thence to Kismayu in the south of Somalia. Their distribution in the south overlaps with the larger cattle types — the Boran and Jiddu. *Garre* cattle are named after the Garre or Gherra tribe who live in the middle and upper Wabe Shebeli area of southern Somalia. They are also known as "Dauara" cattle. Epstein (1971) considered that the *Garre* belonged to the "large zebu" group. It is probably the best milk-producing breed within the Somali zebu. A variety of Garre known as *Bimal*, was previously reported to inhabit the coastal sand dunes between Mogadishu and Meream but its existence at present could not be confirmed, and is thus considered extinct (see Rege, 1999).

The name *Gasara* was originally used to refer to all the small zebu cattle of Somalia, but was found to be unfamiliar to some tribes. Subsequently, usage of the name was united to the cattle of Mudugh, Nogal and Mjiertein. Today the name Gasara is used to refer to the cattle confined to central and northern Somalia — away from the Somali Boran, Jiddu and Garre cattle in southern Somalia. The *Magal* (or *Correi*) cattle in the Juba area was earlier considered to be a variety of the Gasara. It was subsequently noted that "Magal" which means "black" was a description of the cross between the Jiddu and the lead-coloured Gasara.

The North Somali cattle are encountered in western and eastern parts of North-East Somalia. There are two strains: the *Western* and the *Eastern* North Somali cattle. The former is principally found in the Borama-Hargesia area of the North-West province of Somalia bordering Jijiga on the Ethiopian side of the border. They are highly variable in size and colour, roan and spotted being quite common. They have a rather small hump and lyre-shaped horns, features suggesting influence of sanga cattle. *The Eastern North Somali* cattle are found mainly in the Burao area on the eastern side of North-East Province of Somalia. They are characterised by a less variable morphology and are spread in small, isolated pockets. They are also a bit smaller but are considered to have a "better conformation" than the Western type.

The *Baherie* or Arab cattle represent the fourth strain of the Somali shorthorned Zebu. They inhabit an area along the coast of Massawa Region in western Eritrea. They have variously been called *Bahari* (cattle from the Sea / Ocean), *Berbera* (cattle from Somalia), or *Aden* cattle. These names suggest recent origins from Arabia and / or close relationship

with the cattle of Somalia. Giuliani (1936) made reference to similar cattle on the east coast of Somalia and Bettini (1941), observed a few small cattle of a similar type in Mjiertein in the extreme north of Somalia. The present survey could not confirm the existence of these similar types in Somalia (see Rege, 1999).

The Kenya Cluster

In Kenya, the term "Small East African Zebu" has been traditionally used to refer to all zebu populations/strains, except the Boran. In the present survey, an attempt was made to identify these strains or "ecotypes". The strains identified were: the *Kikuyu* or *Highland* Zebu; *Lowland* or *Coastal Zebu* (incorporating the *Taita/Taveta, Giriama, Duruma* and *Kamba* Zebus); *Maasai Zebu* of the Maasai tribe of Kenya and Tanzania; *Winam* or *Kavirondo* Zebu inhabiting the lowlands of Lake Victoria Basin in Nyanza and Western Provinces (ethnic Luo and parts of neighbouring Luhya areas); the *Nandi* Zebu; *Teso* Zebu; *Kamasia/Samburu* Zebu; and the *Watende*, bred by the Watende/Kuria tribes in an area south of the Kavirondo Gulf of Lake Victoria in the Suna–Isebania area towards the Kenya-Tanzania border, adjacent to the western limit of the Maasai. The Watende are fairly deep-bodied, have a smallish hump and short horns. They are usually black, occasionally brown. The Teso zebu of Kenya is related to members of the "Teso group" described later.

The *Nandi Zebu* is owned by a group of closely related pastoral tribes, the Nandi, inhabiting a vast area to the north east of Kavirondo. Known for their long history of cattle raids, the Nandi people are believed to have acquired cattle from several tribes, including the Maasai. Nandi Zebu is small and fine-boned; the hump varies in size, but is usually large and hanging backwards in the bull.

There is not much left of the *Kikuyu Zebu*, having suffered greatly from the impact of upgrading with exotic European cattle since the 1930s. The *Maasai* and *Kamasia/Samburu Zebu* are probably the most phenotypically heterogenous, a reflection of the traditional and continuing raids and counter-raids among these pastoral groups.

The Teso group

This group comprises three strains inhabiting the Teso district of Central Uganda (the *Kyoga* and *Usuk* strains) and in the Serere Peninsula of Lake Kyoga (the *Serere* strain). These strains are at risk of loss due to continued interbreeding with the Nganda and Ankole cattle, especially in recent times. The Kyoga strain is bred by the Kuman tribe in the Lango and Kaberamaido areas. It is larger than the Nkedi, and has a deeper chest and shorter legs. The forehead is broad and ears are usually pendulous. Epstein (1971) contended that the Kyoga was a derivative of Nganda cattle. Our investigation revealed that a typical pure Kyoga animal is (phenotypically) no more crossbred than an average zebu of the Lake region.

The *Usuk* of north and north-east Teso inhabit areas adjacent to the Karamoja. It is larger and heavier-boned than the Nkedi and considered by some to be a product of Nkedi-Karamajong interbreeding.

The *Serere* of south Teso around the shores of Lake Kyoga are quite similar to the Kyoga cattle. Although they have some conformational similarities with the Nkedi, they are slightly larger, but the hump of the Serere is smaller, indeed inconspicuous, in cows. Horns are typically similar to those of the Nkedi (short and thick at the base) but animals with long and thin horns similar to those of the Bahima cattle are also quite common.

The Tanzania cluster

The *Tanganyika* and *Zanzibar Shorthorned Zebu* are found, respectively, throughout mainland and coastal Tanzania, and on the offshore Indian Ocean islands of Zanzibar and Pemba. The *Zanzibar Zebu* is thought to have originated from repeated introductions of Indian cattle and cattle from Barawa on the

Figure 3. N'Dama cattle breed.

Somali coast into Zanzibar and Pemba. Most of these cattle are concentrated in Pemba as the presence of tsetse fly is a limiting factor in Zanzibar. The *Tanganyika Zebu*, erroneously called Tanzania Zebu in the literature, is the mainland type characterised by a broad genetic diversity between and within breeds / strains. The group is widely dispersed throughout mainland Tanzania and consists of various, breeds / strains, some of which are results of earlier local attempts to breed for specific phenotypes, primarily coat colour. For example, it is believed that the *Iringa Red* was created by a Chief who insisted that his people should only keep red-coloured cattle. Other strains include the *Maasai Grey*, *Mbulu*, *Mkalama Dun* and *Singida White*. Strains named after tribal groups or locations are *Pare*, *Tarime* or *Shashi*, *Wachagga* and *Ugogo Grey*. Even though definitive genetic evidence is lacking, remarkable phenotypic diversity is apparent among these populations. For example, those, such as the Mbulu and Wachagga, in the more hilly areas, are much smaller than those in the lowlands such as the Maasai Grey. The *Wachagga* on the slopes of Mount Kilimanjaro, in close vicinity to a tsetse fly belt, have been characterised as "dwarfed, light-boned and weedy", being kept under poor conditions.

Approximately 90% of the *Tanganyika Zebu* are found in the Dodomo area of central Tanzania. The most distinctive strain, the *Ugogo Zebu*, is much smaller but is very well adapted to the harsh environment. They are considered "browsers" because of their selective grazing, including an ability to discriminate between browses during the dry season. Like the *Maasai Grey*, the *Wachagga* or *Chagga Zebu* is found in the Moshi, Upase and Usambara areas of northern Mainland Tanzania, but the latter is a little smaller than

the former. The *Singida White*, *Iringa Red* and *Mkalama Dun* are confined to the Singida region of central Tanzania, while the *Tarime Zebu* is distributed in the Musoma area of the Mara region of the country. The Chagga, Mkalama Dun, Pare and Singida White, with populations estimated at under 5 000 head, and decreasing, are considered at risk (see Rege, 1999). Preliminary results of molecular genetic characterisation suggest that the Tarime has a substantial proportion of taurine influence, most probably a result of sanga (principally Ankole) introgression at the areas of contact.

The Angoni group

The *Angoni* cattle are believed to be descendants of the original zebus introduced through the Horn of Africa. They are the cattle of the Angoni people. Historically, the Angoni people descended from the Nguni tribe which broke away from the Zulu of South Africa in about 1820. They are supposed to have wandered as far north as Lake Tanganyika, raiding cattle along the way. Subsequently, they supposedly migrated with what became known as Angoni cattle to settle, between 1850 and 1870, in the eastern region of present-day Zambia and adjoining areas of Malawi between the Lungwa River in the west and Lake Malawi in the east. They later spread southwards reaching north-western Mozambique. These cattle are today known as *Angoni* in Zambia, *Malawi Zebu* in Malawi, and *Angone* in Mozambique.

In Zambia, the *Angoni* are located between 9^{o} and 14^{o} S latitude and longitude 30^{o} and 31^{o} E, and are confined between Mporokoso and Petanke to the west and the borders with Mozambique and Tanzania to the east. The Zambia Angoni cattle are believed to be still quite pure with the exception of a small amount of exotic influence around Chipata.

Except those in central and southern Malawi, the "Angoni" are generally fairly similar in size and conformation. The Malawi "Angoni" (*Malawi Zebu*) of central and southern Malawi, considered to have been adultered with some sanga blood are more compact than the "Northern type". The two are also different in hemoglobin frequencies (Osterhoff, 1975). That the Malawi Zebu has a hump which is farther forward (i.e. more cervico-thoracic) than would be expected of the typical zebu, suggests possible interbreeding with sanga, most probably Nguni, cattle. The characteristic features of the Nguni are evident in the large ears, the horn shape, the size, shape and position of the hump and the less-developed dewlap of the Malawi Zebu.

The Mozambique Angoni, known as the *Angone* or *Angonia*, is found north of the Zambezi River. Nearly 50 % of them are found in the plateau of Tete in Tete district, while the rest are in a small area of Angonia to the extreme north east on the Malawi border. A strain of the Angoni found along the coast between Lake Malawi and the Indian Ocean is referred to as "*Bovines of Tete*" and is discussed with the zenga group.

The Madagascar group

Madagascar Zebu

The *Madagascar Zebu*, is a relatively homogenous population of thoracic-humped, short-horned zebu found on the island of Madagascar. They are considered to have reached the island either directly from the Indian sub-Continent or via the Horn of Africa. The latter theory is supported by the usage of such Bantu words for cattle as "omby" or "ngombe" by cattle-rearing communities in Madagascar. There is a school of thought which considers that the Madagascar Zebu was derived in ancient times through crossing African sanga with Indo-Pakistanese zebu.

Baria

Found in the Western Region (Plateau de Bemaraha) of Madagascar, the Baria cattle are wild and roam freely. The Baria's classification is uncertain. It has been referred to as a zebu, as sanga and as taurine.

Government reports have, however, been consistent in classifying the Baria as a zebu. Phenotypically the Baria has certain 'zebu features', including presence of a hump. However, the breed has not been sufficiently characterised. The Baria population was estimated at 5 000 head in 1970, but it had declined to an estimated 500 by late 1998, and has been classified in the threat category 'critical' (Rege, 1999).

The Zebu cattle of West Africa

Fulani

The Fulani cattle are mainly owned by the nomadic Fulani people who occupy the belt between the Sahara and the coastal rainforest from the west of River Senegal to the east of Lake Chad, including parts of western Senegal, southern Mauritania, in and around the flood plains of Niger, Chad, northern Nigeria and Cameroon. Origins and classification of the Fulani remains controversial. Tawah and Rege (1996a) have summarised existing theories about the genetic constitution of the Fulani, including evidence suggesting that it has both *Bos taurus* and *Bos indicus* ancestry. Be that as it may, the Fulani is a unique group. It differs from the typical zebu of West and eastern Africa by the presence of long horns and from the cervico-thoracic-humped sanga by the presence of a thoracic, or sometimes intermediate, hump. They have been classified into two sub-groups: The lyre-horned sub-group consisting of the *Senegalese Fulani* (or the *Gobra*), the *Sudanese Fulani*, and the *White Fulani* (or *Bunaji*); and the *long lyre-horned* sub-group represented principally by the *Red Fulani* (or *Rahaji*). *Diali* (or *Djeli*) is a strain of Fulani found on the flood plains and adjacent valleys in that portion of Niger River in Niger and southwest Nigeria.

The *Gobra* and *White Fulani* are predominantly white in colour and are much larger than the Sudanese Fulani which has quite a variable coat colour, usually spotted light grey. The White Fulani is the most numerous and widespread of all the Nigerian cattle breeds, representing some 37 % of the national cattle population. In Cameroon, they represent 33% of the national cattle herd and are only second to the Red Fulani. The White Fulani cattle have been comprehensively reviewed by Tawah and Rege (1996a).

The *Gobra* is the dominant breed in the northern savanna of Senegal and in adjoining regions of Mauritania. Considered principally a beef animal it yields some 550kg of milk over a 180 day lactation period. The bulls and oxen are also used for riding and as pack animals. Of the Fulani cattle, the Gobra have the longest horns.

The *Sudanese Fulani* is found in western Mali along the flood plain of the Niger River from Segon to Timbuktu. They have either lyre-shaped or crescent shaped horns. Most of the cattle are grey with dark patches, but animals with white backs and black speckles are not uncommon.

Gudali

Gudali is a Hausa word for "short-horned and short-legged animals". It is generally used to embrace a large group of short-horned zebus which are also referred to variously as *Fulbe* or *Peuhl Zebu* in West and Central Africa. The Gudali are principally found in Nigeria, Cameroon and Central African Republic, but a small population also inhabits Ghana. Gudali cattle are traditionally kept by Fulani and Hausa pastoralists. There are two major sub-groups of the Gudali: *Sokoto* and *Adamawa* Gudali. Within the Adamawa Gudali, three breed strains are recognised: *Ngaundere*, *Banyo* and *Yola*. All three Adamawa Gudali strains are found in Cameroon, but only the last two exist in Nigeria.

The names of Gudali breeds/strains derive either from their location (e.g. Sokoto, Adamawa, Ngaundere, Banyo and Yola) or the name of the owning tribe (e.g. Fulbe, Peul, Poulfoulo, Fulani), or, in some cases, predominant colour markings (e.g. Tattabareji, a Fulani word for "speckled coat

Figure 4. Ngaundere Gudali cattle breed.

colour" is used as a synonym for Yola Gudali). The Gudali is a long, well-proportioned and relatively compact animal, with a deep, wide body and well-sprung ribs. They are deeper-bodied than the White Fulani, giving them a "close-to-the-ground" appearance. They closely resemble the Boran of East Africa in conformation, size and type. They are also considered to have some similarities with the Kenana of Sudan. There are large variations in coat colour and mature weight between and within the Gudali strains. Tawah and Rege (1996b) have recently made a comprehensive review of the Gudali.

Azaouak

The *Azaouak*, also known as *Tuareg* are cattle of the nomadic Tuaregs and Arabs found in the Azaouak valley in a vast, windy depression stretching 3^{o} to 7^{o} E longitude and 15^{o} to 20^{o} N latitude, covering the arid eastern Mali in the Niger River bend through southern Niger to parts of northern Nigeria. It is considered very well adapted to drought. It is compact and is suitable for beef production and is also used for work. It is routinely milked. They are usually a mixture of red and white, black and white or fawn with white patches. Other local synonyms are the Adar (Nigeria), Azawa, Darmeghou, Tagama (Niger) and Azawaje.

Shuwa

The *Shuwa* or *Arab Shuwa, Arab Choa* or *Wadera* cattle are found throughout Chad (except the southwest), in northeastern Nigeria and in the extreme north of Cameroon. It is considered to have some humpless Shorthorn blood, but phenotypically it is zebu. These animals were brought to the area by migrant Arabs. They are small but well-muscled, deeply built with rounded ribs. They are considered to be good dairy animals, with milk off-takes of 450 - 1 820 kg in lactations lasting 240 - 370 days. They are used for riding by women and as pack animals.

Maure

The Maure cattle are found in the Sahel region of Mauritania and neighbouring Mali. They are owned by nomadic Arabs and Berbers. Humps are more prominent in the eastern part of their distribution range, suggesting possible Fulani influence. They are used by women as pack and riding animals. Cows are valued for their milk yields which average 650 kg over 210 – 240 days. They are usually black or black-and-white, but dark red coats are common in the east. The Maure is loosely built and tends to be more leggy than the Azaouak. Synonyms include *Arab, Mauritanian, Moor* and *Moorish.*

The Sanga of Africa

The area of distribution of sanga cattle extends from Eritrea, through Ethiopia, southern Sudan and the Great Lakes region of East Africa to southern Africa where they are the traditional cattle in all countries south of the Zambezi. It is also considered that before short-horned zebu became dominant in eastern Africa, the sanga was ubiquitous in this area. Ethiopia and environs is considered to be the centre of dispersal of the sanga.

Sanga cattle vary in size from very small to large. The head is usually long, moderate in width with a convex or straight profile. The horns vary greatly in length, base circumference and orientation. Polled sanga are rare. On the basis of horn size and form there are two types: Those with long, relatively slender horns; and those with gigantic horns of great basal circumference. The sanga humps range from small, almost inconspicuous, to medium. Like in the zebu, the hump is more prominent in bulls than in cows and is better developed in some breeds, than others. The hump position varies, but is typically cervico-thoracic. The hump is more thoracic (and larger) in areas with large zebu influence. The sanga hump is typically muscular in structure, not musculo-fatty. While there are hardly any breed improvement programmes for the sanga of eastern Africa, the majority in southern Africa have well-organised programmes and most have Breed Societies.

The sanga of Eastern Africa

Nilotic sanga of southern Sudan and south-western Ethiopia

The sanga cattle of Sudan are found in the southern part of the country, mainly in Bahr el Ghazal and Upper Nile Provinces and the Mandari area of the Equatoria Province, from where they extend into the Akobo-Gambela area of southwest Ethiopia, but here they are restricted in distribution due to tsetse infestation, especially farther inland into Ethiopia. Strains of these cattle, known by names of the tribes, are bred by the *Dinka, Nuer* and *Shilluk*, and to a small extent by the *Anuak*. Several local varieties (*Aliab Dinka, Aweil Dinka, Eastern Nuer* and *Ethiopian Anuak*) could formerly be recognised. With increased communications and tribal admixture, the clear distinction between sub-types has diminished. However, the variation in size between locations is still discernible. Moving from west to east of the enclave of the Nilotic tribes, one finds small, light-bodied, refined animals to the west, and

larger, more heavily built types in the east, around the Sudan–Ethiopian border area. Body conformation also varies immensely between sub-types, as does horn size and shape. The hump also varies in size from very small to moderately large, the latter being more frequent in those strains with heavy zebu influence. In the bull, the hump may lean slightly over at the back and resemble a zebu hump. This is the case among the *Dinka* strain and has prompted suggestions that Dinka cattle are not typically sanga. Among the Dinka, particularly Aliab Dinka, light coat colour, usually white with red or black patterns, is most common. Some Dinka cattle imported into Congo (Democratic Republic) in the 1900's assumed the name *Wadai Dinka,* but the breed is considered extinct (Rege, 1999). The *Abigar* is a sub-type of the Nuer cattle found principally in the border areas, with a large extension into Ethiopia covering the Akebo area of Gambella. While the Dinka may still be distinguished as that population found in south-east Sudan around Bor (the *Aliab Dinka*) and in the north-west of the Nilotic territory-south of 10^{o} N latitude, (the *Aweil Dinka*), *Shilluk* boundaries with the other strains has become rather diffuse. The Aliab Dinka is distinctly larger framed and bears resemblance to the North Sudan Zebu. The Aweil Dinka on the other hand is smaller in frame and has a finer bone structure.

Abyssinian sanga

Today, the only true sanga in Ethiopia, other than the Nilotic *Abigar* on the Sudan border, are owned by the Danakil and the Galla-Azebo tribes. The sanga strains kept by these tribes are correspondingly called the *Danakil* (*Adal,* or *Keriyu)* and *Galla-Azebo* (or *Raya-Azebo*). The *Danakil cattle* are also kept by Afar people. The breeding area of the Danakil is the Awash River Valley (Harer and Shewa, in Wello, parts of Tigray and Afar, stretching into parts of Djibouti). *Raya Azebo* is found east of Lake Ashangi in Tigray and bordering areas of Wello, particularly in the northern parts. Beyond the borders of this breeding area, extending into southern Eritrea, the sanga are greatly interbred with the zebu. This is the habitat of the zenga known as Arado. The Danakil and Raya Azebo are large animals with immense, lyre-shaped horns, small humps and moderately developed dewlaps. The horns sometimes grow upwards and inwards over the head, forming a complete or almost complete circle. They are mainly light chestnut or ash-grey in colour. These two breeds are only distinguishable by the geographical location and the fact that Raya-Azebo is a slightly bigger animal, probably a result of selection for work, being an important source of draught power in this area of settled agriculture.

The Ankole group

The original Ankole stock were supposedly brought to northern Uganda by the Bahima pastoral Nilotes from the north, from the epicentre of sanga dispersal in the Ethiopian highlands, sometime between 13th and 15th centuries. Subsequently, the Ankole cattle were pushed southwards and westwards by tsetse fly. The Bahima settled in western Uganda, but some clans proceeded farther south, west of Lake Victoria, down the eastern border of the then Tanganyika. The Watusi (or Tutsi tribe) are considered to have continued to the Rwanda–Burundi area. From the original cattle there evolved several basic types of Ankole associated with the tribal groups – e.g. the *Watusi, Bahima, Bashi* and *Ruzizi*.

The Ankole of *the Bahima* are among the most typical sanga and, until the recent conflicts in the Great Lakes region (civil strifes in Uganda in 1970s to 1980s and the conflicts in Rwanda and Burundi starting in the early 1990s), had been free from the zebu influence seen in the sanga of Ethiopia and Sudan. These cattle are large to medium in size, tall at the withers, but not particularly heavy. The horns are the most conspicuous and highly regarded feature of the Ankole cattle. The horns are very large, projecting from a pedestal-like base outwards and upwards, from where they may curve to form a circle or crescent or they may spread out. The hump is

small and cervico-thoracic and the dewlap is moderately developed. Coat colour is mainly dark red, but black, brown, white, grey and dun, as well as combinations may also be found. Almost all Bahima cows are milked, despite the low yields.

The *Watusi* strain, found in Rwanda and Burundi and the northern shores of Lake Kivu have much larger horns than the Bahima. The horns range from 70 to 110 cm in length but may be so huge as to hamper normal movement. The Watusi animals are not as large as the Bahima. The neck is relatively short, and the legs are weak. The common coat colours are brown, red and black, often variegated with white. They are shorter than the Bahima cattle.

The *Bashi*, named after an agricultural Bantu tribe of the same name who arrived in the area in the 17th century, is found in the west and southwest of Lake Kivu. It is smaller than the Bahima but of finer build. Horns are generally large, but size and shape are quite variable. The hump is small, but is also variable. The body is short and compact and the chest wide and deep, the sacrum slightly higher than the withers. The legs and joints are strong and the udder and teats fairly well-formed. The coat is mainly red, black or fawn, but mixtures of colours do also occur. The Bashi is slow-maturing. It is milked, producing 300-540 kg over a 100-260 day lactation.

Kigezi District in the extreme southwestern corner of Uganda is home to cattle differing from the majority of Ankole cattle of Uganda. The *Kigezi* cattle are slightly smaller, and finer bodied. The horns are smaller in base circumference and usually shorter in length and more upright than the Bahima type. They also tend to have a paler coat colour than the other Ankole. They are generally similar to the Bashi type.

The *Ruzizi* cattle are found in the Ruzizi valley and in the mountains to the west of the Ruzizi River, between Lake Kivu and Lake Tanganyika, near the border of the Democratic Republic of the Congo with Rwanda and Burundi. This is a strain of the Watusi cattle distinguished by long sickle- or lyre-shaped horns and a very small cervico-thoracic hump. They are considered better milkers than the other sanga of the Kivu region. The coat is usually brown, but red, red-and-white and black-and-white are also found. Also called *Rwanda-Burundi cattle*, the Ruzizi is taller, better built and faster maturing than the other Ankole cattle of the Lake Kivu area. It reportedly fattens well on pasture.

The sanga of Southern Africa

The Shona group

The *Mashona*, the only member of this group, are the traditional cattle of the Shona people of Zimbabwe. Their breeding area extends eastwards over the Mozambique border into a small tsetse-free area south-west of Tete and south-westwards into parts of Matebeleland, including Matopo Hills. It is considered to have received substantial influence from the Angoni cattle and some workers have classified it as a zebu–sanga type. The Mashona is a well-proportioned, fine-boned, strong and sturdy animal used principally for beef production and as a work animal. The common coat colour is black, while red is not uncommon. Other colours are brown, dun, yellow, cream, brindle, red-and-white and black-and-white in various combinations. Black-and-tan merging into each other is also a frequent pattern. Mashona breeders favour solid colours, particularly black. There is a breeding programme for the breed overseen by a Breed Society.

The Nguni group

The Nguni are the cattle of the tribes belonging to the original Nguni tribes, including Swazi and Zulu. They are found in Swaziland (where they are the majority), the eastern part of Zululand through southern Transkei (and in several commercial farms) in South Africa, and in Mozambique. While the populations in Swaziland and South Africa are called *Nguni*, the strain in Mozambique is referred to as *Landim*. The Nguni are of

medium size. Unimproved animals are small, with withers height of about 105 cm and weighing about 225 kg. Under good management bulls attain withers height of 135 cm and over 500 kg liveweight and cows 125 cm and 350 kg. The body conformation of the Nguni is more like a dairy breed, but it is principally used for beef production and for work. Lactation milk yield as high as 1 200 kg, over 298 days has been recorded. The Nguni is quite diverse in coat colour: White, black, brown, red, dun, yellow are common, either as solid colours or in various combinations (black-and-tan or brindle). Animals of solid black colour play an important role in ceremonial life of the Swazi and Zulu. There are elaborate breed characterisation and improvement programmes for the Nguni in Swaziland and South Africa and there is a strong breed Society.

The cattle of the Bapedi sub-tribe of the Nguni, in the Sekhukhuneland area of Eastern Transvaal, are a strain of the Nguni called *Pedi* or *Bapedi*. The predominant colour of the Pedi is black with white on the belly and lower neck area. Blue roan and white with black spots are also common.

The *Nkone*, also known as *Manguni*, represent perhaps the only surviving population of what has been called "Matabele" cattle. Historically, the Matabele nation broke away from the Zulu in Natal in 1817 during Chaka's reign. They settled first in Transvaal, but later, following the arrival of the Boers, moved farther north into the area now known as Matabeleland in southern Zimbabwe. Along the way they acquired cattle of a very mixed derivation. It is considered that the original Manguni cattle, which was principally Nguni, received infusions from Zansi cattle, probably from Zululand, "Boer cattle", Ngwato and Ngami cattle from, Bamangwato and Botawana tribes of Botswana, Mashona cattle, Barotse, Tonga and Afrikaner cattle. Thus, although the Nkone is classified as of the Nguni descent, it is probably genetically more heterogenous than, and more distant from, the other members of the Nguni group. There is only a single pure Nkone herd based at the Matopos Research Station.

The Zambia/Angola cluster

Tonga

A long-horned sanga breed, *Tonga* are the cattle of the Tonga and related ethnic groups (the Ila-Tonga peoples). They inhabit southern Zambia, extending from the Zambezi valley northwards and eastwards to the Sunemfwa River and westwards to the Manyeke River. Tonga cattle are smaller in size than the Barotse. The body is long but of good depth, although often narrow behind the prominent shoulders and at the pin bones. Common coat colours are black, red or patterns of black-and-white or red-and-white. Occasional all light brown or dun is also spotted. There is no breed improvement programme for the Tonga.

Porto-Amboim

The *Porto-Amboim*, named after a coastal Angolan town of similar name, is considered a variety of Barotse cattle. It is found in northern Angola and southwest D.R. Congo (former Zaire) where they are bred by nomadic tribes. The animals are considered poor milkers. Their long, sometimes loose, horns are shorter and more variable than those of the Barotse cattle. The hump is also rather variable in both size and shape. The coat colour is beige to brown, either solid or pied. It is smaller than the Barotse and is poorly muscled. The hump is less pronounced. In Angola they are found in widely separated parts of the western plateau and in scattered locations along the coast. No breed improvement programme exists for Porto-Amboim.

Ovambo and South-Western cluster

The *Ambo* or *Ovambo* cattle belonging to the Ovambo of southwest Angola and northern Namibia, comprising Ovamboland and

Kaokoveld, are generally small in size but well-proportioned. The *Ovambo* tend to be smaller and lighter, rather diminutive compared to the much larger *Kaokoveld* cattle. These cattle have shorter legs and are sturdier than the Setswana cattle. The horns are long, massive and lyre-shaped and circular in cross-section. The hump is cervico-thoracic and the neck moderately long and fairly deep. The dewlap is heavy and folded, thick of skin. The chest is small, of medium width but of fairly good depth. The common coat colour is uniform light or dark dun, slightly darker on the head and over the shoulders and withers. Black, red or black-and-white with white top and underline are not uncommon. Anecdotal reports suggest that the Ovambo and Kaokoveld are, other than size difference, basically similar.

There are two other sanga breeds, found predominantly in Namibia but whose clear definition as distinct strains is lacking. The *Okavango* cattle are cattle that are quite similar to the Ovambo but are located on the right bank of the Okavango River in conditions intermediate between those of the Ovambo and the Kaokoveld. The body size of the Okavango is "about midway" between the Ovambo and Kaokoveld. The term *Caprivi sanga* has been used to refer to another type of sanga cattle of Namibia found in the Caprivi Strip, the long strip in north-east Namibia bordering four countries – Angola, Zambia, Zimbabwe and Botswana. Cattle in this area may have the influence of cattle types from all the adjoining countries.

South of Damaraland, in the northern part of Great Namaqualand, used to be the habitat of *Nama*, cattle brought there by the Rehoboth tribe but which were considered a product of crossbreeding involving Hottentot, Damara and Ovambo cattle with European breeds, particularly Friesian. They were supposedly taller and had better conformation than the Damara and Ovambo breeds. However, like the Damara cattle, the Nama suffered greatly from the rinderpest devastations of 1899/1900 followed by the conflict involving German forces (1904-1908). Some 600 Nama cows were supposedly saved and subsequently used to develop a new strain incorporating European breeds and cattle from the Cape Province.

The cattle kept by the Ovambo tribe of southwestern Angola are locally known as *Humbi*, *Humbe*, or Angola cattle. They differ from the other sanga of the region in that they have a large, heavy and folded dewlap and a sizeable naval fold and sheath. The coat is light to dark beige with a darker front and, often, a white-shaded bottom line. The animals are small to medium in size with long, massive, usually lyre-shaped horns. There is not much going on in terms of genetic improvement of members of this cluster. However, there is substantial on-station characterisation of populations in Namibia.

The Setswana group

The term Setswana has been used to encompass a group of similar sanga breeds which used to occupy the vast arid grassland region in the middle of the northern part of southern Africa and southern part of central Africa. In this context it has also been used to include the sanga of Zambia, Angola and Botswana. Here it is used in a more restricted context.

The *Barotse* are cattle of the Barotse or Lozi tribe, inhabiting the western part of Zambia along the Zambezi river and its tributaries and extending into Angola as far west as 20° E latitude. The Barotse is coarse-boned and large. The legs are long or of medium length, enhancing the langy appearance of the breed. The Barotse are mostly black and brown, but red is not uncommon while dun and fawn are occasionally seen. Barotse is docile and makes a good work animal. They are mainly used for meat, but are also milked. The breed has been studied on-station but there is no on-going programme for its management.

The *Damara*, or *Herero* cattle of southern Namibia were originally a Setswana sub-type. The most remarkable feature of the cattle of the Damara and Herero tribes of central and eastern Namibia was considered to be their horns – beautifully arched and twisted, rarely

bending inwards and of incredible length. The traditional Damara herds tended to consist of animals of the same colour, bright brown being one of the most popular. It is considered that the Damara cattle were decimated by the 1899 – 1900 rinderpest epidemic and subsequently by the introduction of European bulls and interbreeding among cattle of various tribal groups. The cattle owned by the Damara and Herero today are large and "not typical" of what the native cattle used to be: Average horn size is considerably shorter, moderately thick at the base, with thin pointed tips, sickle- or lyre-shaped; the hump is cervico-thoracic, but moderately larger than the other Namibian sanga types.

Botswana is the epicentre of the distribution of Setswana cattle. The Tswana people settled with their livestock in the Ngami region of Botswana early in the 19th century and their cattle eventually displaced practically all the original Ngami animals. Today all sanga cattle in Botswana are basically of Setswana type. Several sub-types have been distinguished. These include *Botawana*, *Bamongwato*, *Damara*, *Sengologa* and *Seshanga*. As a result of constant contact between tribal groups and movements of people and their cattle, old names have been replaced by new ones and certain sub-types subsumed into others. Additionally, crossbreeding has occurred with Afrikaner and European breeds. Epstein (1971) contended that it was still possible to distinguish between Western (*Ngamiland*) and Eastern (*Batawana*) types. This may very well be so. However, all official reports have tended to pool all the sub-types into the *Tswana* breed. The most typical Tswana cattle now occur mainly in the north and north-west of the country in Ngamiland and along the Boteti River. Local Tswana cattle populations, named after the tribal areas where they are kept, are still recognisable in many areas. Tswana-type cattle extend into the southwestern corner of Zimbabwe. Among the distinct breeds that are highly threatened in the process of the "consolidation" of the Tswana breed are the Sengologa and Seshaga which previously inhabited central Kalahari and the Sekgatla cattle of the Bakgatla Reserve. Although rather heterogeneous phenotypically, today's Tswana cattle are generally long-horned, well-built, well-fleshed with moderate to long legs. There is a Government programme for the characterisation and improvement of the Tswana..

Tuli

Red, red-and-white and golden brown were the most common coat colours of cattle of Ngwato Setswana type in South-west of present-day Zimbabwe, the *Amabowe* cattle. Following the 1896 rinderpest epidemic and subsequent indiscriminate crossbreeding of the remnant stock with the Afrikaner and European breeds, the original Amabowe cattle were all but wiped out. In the 1940s, the best of the remaining Amabowe cattle were collected in the Tuli area. Subsequently, a breeding programme was set up at a station in Matabeleland where systematic and sustained selection for beef characteristics, hornlessness and golden-brown colour was implemented. The product was the *Tuli* breed, also called "*Harvey's Cattle*" after the settler farmer who collected the original Amabowe animals. The Tuli is a success story. The breed is now widespread in southern Africa and has been exported to Australia, USA and Canada. The Breed Society is strong and strict breed standards are followed.

Afrikaner

The Afrikaner falls into a group of its own. Previously called Africander, the official name of the breed today is *Afrikaner*. A substantial proportion of the breed is in commercial farms. It is probably the most popular indigenous breed in South Africa, accounting for about 33 % of the cattle population. It has been exported to several countries in southern Africa – Namibia, Botswana, Swaziland, Zimbabwe, Zambia, Malawi and southern parts of D.R. Congo (former Zaire) – and to

Australia and USA. The most important breeding areas of the breed are Hoopstad, Kroonstad and Winburg, in northern, central and southern parts of Orange Free State. Some key herds are also found in the Midlands of Cape Province, and around Pretoria, Potchefstroom and Klerksdorp in Transvaal. The Afrikaner breed traces its origin to the cattle which the early European colonists of South Africa found in the possession of the Cape Hottentots. These were acquired starting about 1652 and improved as draught animals, and were used as riding and pack animals in the Great Trek of 1835 to 1836 from the Cape to the Orange Free State, Natal and the Transvaal. An old breed, the Afrikaner has been bred according to "breed standards" for many generations and shows a high degree of uniformity in colour and conformation, rarely encountered in other African livestock breeds. The colour ranges from dark to light red. Yellow, varying in shade from dark honey to light cream was previously popular with breeders, but the yellow strain is increasingly less common. The long spreading horns leave the head in a downward and backward direction, then, at maturity, bend gracefully forwards, upwards and backwards. Many breeders still attach great importance to the placing of the horns, their uniformity in thickness, and their oval shape. A polled type has been developed. The hump (prominent but not large) is cervico-thoracic. By all measures, a beef-type, the Afrikaner is a heavy animal. Adult cows average 525 kg and adult bulls 745 kg, but Show bulls may exceed 1 100 kg and cows in good condition 800 kg. The animal has brawny thighs, well-muscled withers, and a deep broad chest with round ribs.

The Zenga Cattle of Eastern Africa

Sanga cattle left behind a trail of zebu-sanga crosses. The breeds that emerged from these crosses have been classified in a separate group, the "*zenga*". The location of the *zenga* in eastern Africa is not surprising: the region represents the point of zebu-sanga contact and is also the natural division between the predominantly "sanga country" in the south and "zebu country" in the north. No breed improvement programmes exist for any of the zenga. However, there is an on-going on-station characterisation of the Horro. Table 1 summarises the probable composition, the distribution and characteristics of the zenga breeds.

Recent derivatives

There are several cattle breeds which have been formed as a result of coexistence of two or more breeds in close proximity to each other. In most cases this has been facilitated by increased interaction among tribal groups and sometimes deliberate but non-systematic attempts to improve specific qualities.

The transition between the Savanna and the Forest Zones of West Africa is the home of several "crossbred populations" some of which are locally recognised as breeds. Aboagye *et al.* (1994) and Rege *et al.* (1994a; b; c) have described, in detail, five such "breeds" in West Africa – the *Borgou* (Zebu x Somba or Lagune), *Méré* (zebu x Lobi, Baulé or N'Dama), *Ghana "Sanga"* (Ghana Shorthorn x Zebu), *Keteku* (Muturu x zebu), *Biu* (Dwarf Muturu x zebu), and Djakore (Gobra x N'Dama).

Basuto

Present-day Lesotho (formerly Basutoland) was the home of large herds of *Basuto* cattle prior to the great rinderpest epidemic at the end of the 19th century. Subsequently these cattle were substantially influenced by black sanga cattle from the Drakensberg Mountains and European breeds. Generally, Basuto cattle are smaller than the Nguni and resemble Mashona cattle. They are used mainly for work, but are also milked and slaughtered for meat. Their milk production is, however quite low, and muscular development rather poor. The original Basuto cattle is non-existent today in any significant numbers. The genetic composition of present-day Lesotho cattle

Table 1. Composition, distribution and characteristics of Zenga cattle.

Breed	Probable Composition	Country and areas within country	Main characteristics
1. Horro	Various strains of Ethiopian Highland Zebu and Nilotic sanga, particularly Abigar.	Ethiopia: Horro Gudru of eastern Welega; also western Shewa, and contiguous areas of Ilubabor and Shewa.	Small to medium cervico-thoracic hump; dewlap moderate and thin of skin; horns moderate but larger than zebu ones, deep chest and barrel, well-sprung ribs; udder small but well proportioned, good teat placement; calm disposition; coat colour mainly brown or reddish brown. Variable milk production (700-1350 kg/lactation of 3-8 months). Used for milk, draught and meat.
2. Fogera	Various strains of Ethiopian Highland Zebu, Nilotic sanga and Abyssinian sanga.	Ethiopia: Fogera plains around Lake Tana, southern Gondar and adjoining areas of Gojam.	Black-and-white or black-and-grey coat; short stumpy, pointed horns; hump ranges from thoracic to cervico-thoracic; dewlap is folded and moderate to large. Docile; used for draught, milk and meat.
3. Arado	Barka, various Abyssinian Zebu, and Abyssinian sanga.	Eritrea: highland areas from Senheit southeast to northern parts of Akale Guzai & southwards to areas of Seraye. Also contiguous areas of northern Ethiopia in Tigray-northern Shire, Adwa & parts of Agame.	Coat red, from light to dark shade; red-pied & black-pied common; solid black, brown, grey or white also occur. Hump thoracic to cervico thoracic, small to medium. Body has good depth & length; dewlap well-developed. Docile, very good work animal. Milk yield low; also used for meat.
4. Jiddu (or Tutu)	Somali Boran, Ethiopian Boran, and undetermined sanga ancestry.	Somalia: Ballei on Juba River, Juba Districts of Gasha & Lugh; along Benedir coast between lower Wabe Shebeli River and Indian Ocean. Previously existed in contiguous areas of Kenya (N.E. Province).	About same size as Somali Boran; fleshy, well-proportioned, good depth, well-sprung ribs, large body, fairly short legs. General "type" that of dairy. 450-900 kg/lactation of 6-9 months. Moderate to heavy head, straight profile. White eyelashes, white hair around eye area and inside ears. Body is white, light fawn and dark mahogany; moderate hump, thoracic to cervico-thoracic. Used mainly for milk, but also for meat.
5. Nganda	East African Zebu (mainly Nkedi), Ankole (mainly Bahima strain, but also Watusi in recent times).	Central Uganda, north of Lake Victoria and between L. Kyoga & L. Albert; also tsetse infested south of L. Albert & east of Semliki River.	Horns round in cross-section, white, thick at base and long; hump cervico-thoracic and small; dewlap moderate in size; variable coat colours: red, black and brown most common. Used for milk, work and meat.
6. Sukuma	Various strains of Tanganyika Zebu, and Ankole of Rwanda-Burundi area & southern Uganda.	Tanzania: Sukumaland, a region south of L. Victoria on eastern border of Mwanza and north eastern parts of Shinyanga, an area covering Seke, Lalago, Nyalikangu & upper Semu River.	Horns medium to long, large & crescent-shaped; small hump; dewlap small, thin of skin; coat colour red or grey roan, light dun or solid red. Used for milk and meat: also for work.
7. Alur (or Nyoka, Nioka or Bukwa)	Tugware and Nkedi, and various strains of Ankole.	Eastern D.R. Congo: Upper Ituri covering Nioka-Mahagi-Djugu area.	Hump small to medium. Body compact; moderate sized dewlap; horns short to medium-long (shorter than Ankole's); More Bahima- than zebu- looking; colours: red, red-pied, brown and black. Used for milk, but also for meat.
8. Bovines of Tete	Angonia and Landim.	Mozambique: narrow coastal strip between L. Malawi and Indian Ocean.	Thought to have level of tolerance to trypanosomiasis. Used mainly for meat, but also milk and work.

Table 2. Commercial composite breeds of sub-Saharan Africa.

Breed	Composition	Country	When initiated	Registered	Characteristics, uses and status
1. Bonsmara	5/8 Afrikaner, 3/16 Hereford, 3/16 Shorthorn (European).	S. Africa	1920s through 1930s Recognised 1964.	Yes (1972)	Beef breed adapted to hot climate; resistant to sun, heat and ticks. Breed improvement programme exists; population size: 143 000 (1998).
2. Drakensberger	Friesian, Afrikaner, Basuto, "Zulu cattle", and "Black sanga"-unknown proportions.	S. Africa	Early 1900s; Recognised 1947.	Yes (1977)	Beef breed; also good work animal: also milked by some. Adapted to extremely hot climate; sleek, shiny, black coat. Breed improvement programme exists; population size: 149 000 (1998).
3. Maojan'i Boina	Madagascar Zebu and Brune des Alpes-unknown proportions	Madagascar	1980s.	No	Dairy breed created for the hot coastal climate of Mahajanga province, still in early stage of breed formation; Population size: 200 (1998).
4. Mpwapwa	35% Red Sindhi, 20% Sahiwal, 20% Tanganyika Zebu, 10% Boran, 5% Ankole, 10% *Bos taurus* (mainly Ayrshire).	Tanzania	1958 (based on crossbreeding work started in 1930s).	No	Dual purpose (beef & milk) with only moderate milk production; created for dry areas of Central Tanzania. No sustained programme, no on-going multiplication. Breed is at risk. Population size: 1 000-1 500 (1997). No "purebreds" left on farms.
5. Renitelo	50% Limousin, 25% Afrikaner, 25% Madagascar Zebu. ("Renitelo" means "three mothers").	Madagascar	1951 (based on crossbreeding work started in 1946).	No, but recognised as breed in 1965.	Beef animal created for Madagascar conditions. Produces "2 times more beef" than Madagascar Zebu. No breed development programme. Interest previously waned, renewed Government interest in 1992. Population size: 2 000-3 000 (1997).
6. Wakwa	1/2 Brahman, 1/2 Ngaundere Gudali.	Cameroon	1953	No	Beef animal created for low to medium input systems. Was popular but numbers failed to meet farmer demand. No programme to further multiply and develop breed. Population size: from 500 (in 1970s) to less than 100 (in 1987) on station. No "purebreds" left on farms.

Figure 5. Lagune cattle breed.

comprises the Drakensberg cattle, remnants of the original Basuto, Afrikaner and Friesian cattle introduced subsequent to the rinderpest plague.

Rana

Rana is derived from crossbreeding between the Madagascar Zebu and bulls first imported from France in 1840. The sire breeds were Bordeaux, Gascony, Garonne, Breton Black Pied and Normande. Although the initial crossbreeding was rather unsystematic, subsequent interbreeding over generations and the pursuit of similar breeding objectives, produced a more or less uniform population of dairy cattle known as *Rana* or *Omby Rana*. However, as a result of additional importations of Normande cattle between 1926 and 1930 followed by extensive and rather indiscriminate crossbreeding to improve milk yield, most of the animals around Tananarive became more "Normande-like". Moreover, from 1945 onwards Friesians were introduced into Madagascar in an attempt to further improve milk production. More recently, Norwegian Red has also been imported. These breeds have been used on both Rana, Normande-Rana crosses and the local zebus and have produced a wide range of genotypes. Although the Friesian was generally much less adapted (than Normande) and did not survive well, except on the higher altitude areas, the combined impact of the Friesian, the Normande and more recently introduced exotic breeds has been a serious dilution of the Rana as it was known in the early 1900s. Today the estimated population of the Rana is some

40 000 to 85 000, but even this liberal estimate includes a rather large number of "recent crossbreds". A "true Rana" is fine-bodied and has more of a dairy conformation than the zebu. Milk yield is 4-9kg a day in a 5-8 month lactation. A yield of 2 850kg has been recorded in a lactation of 295 days.

Barra do Cuanzo

The *Barra do Cuanzo* of Angola is an improved breed with apparently good beef characteristics. It is thought to have descended from Porto-Amboim or Barotse cattle. The breed is primarily owned by European farmers in the Cuanzo district, in the coastal plains south of Luanda. It is considered that the breed contains blood infusions from European breed, particularly the Charolais.

Commercial composites

The breed composition, characteristics and the status of development of the six composite breeds of sub-Saharan Africa are summarised in table 2.

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Conservation considerations on Danish Shorthorn Cattle using pedigree analysis

M. Trinderup[1]***, J.N. Jørgensen***[1] *&* ***M. Hansen***[2]

[1] *Department of Animal Science and Animal Health, the Royal Veterinary and Agricultural University, 13 Bülowsvej, 1870* ***Frederiksberg C****, Denmark*
[2] *The Danish Agricultural Advisory Centre, The National Committee of Danish Cattle Husbandry, 15 Udkjærsvej, Skejby, 8200* ***Århus N****, Denmark*

Summary

The gene dropping method was applied to the pedigree of Danish Shorthorn in order to estimate the proportion of alleles of the old type of Danish Shorthorn in the population of 1997.

It was found that about 23% of the alleles in the population of 1997 originated from the old type. Of 21 base animals of the old type, alleles of seven animals were completely lost in the gene dropping while only six base animals contributed with 20.2% of the alleles in the 1997 population. Inbreeding coefficients ranged from zero to 35.6% with a mean of 4.1%.

Résumé

La méthode *gene dropping*a été appliquée pour le pédigré du Danois à courtes cornes afin d'estimer la proportion des allèles appartenant au vieux type de Danois à courtes cornes dans la population en 1997. On a trouvé que 23% des allèles dans la population en 1997 provenait du vieux type. Parmi les 21 animaux de base appartenant au vieux type, les allèles de sept d'entre eux ont été complètement perdus pendant le *gene dropping*, tandis que seulement six des animaux de base ont contribué avec 20,2% des allèles pour la population de 1997. Les coefficients de consanguinité vont de zéro à 35,6% avec une moyenne de 4,1%.

Key words*: Diversity, Beef cattle, Gene dropping.*

Introduction

Conservation of genetic diversity has, through recent decades, become increasingly more established in animal breeding, in theory as well as in practice (Bodó, 1990a). In Denmark, the Ministry of Food, Agriculture and Fisheries has appointed a National Committee of Conservation of Genetic Resources in Danish Livestock. The Committee manages the work of registration and circulation of breeding animals and renders advice concerning breeding systems and the collection of semen and embryos for cryogenic storage (Vigh-Larsen, 1996). The cryogenic storage of breeding material is managed by the Nordic Working Party on animal gene banks (NAGB) (Maijala *et al.*, 1990).

In agreement with the global consensus that in general it is the obligation of the country of origin to maintain an autochthonous breed (Bodó, 1990b), a list of breeds to be conserved in Denmark has been drawn up (Maijala *et al.*, 1990). All but one of the cattle breeds on the list originate in Denmark. The exception is the Jersey cattle, but in Denmark the Jersey has developed a new type that can be considered as a new

population with sufficient conservation value (Bodó, 1990b) and therefore are considered in the conservation work.

The Shorthorn is a cattle breed known world wide, originating in England and therefore of apparently no obvious interest to the Danish Committee. Yet there have been suggestions from some breeders for Shorthorn in Denmark to include the Danish population of Shorthorn in the conservation work. The arguments are that the Shorthorn has an interesting history in Denmark as it was the first beef cattle breed to be introduced into the country and that the Danish Shorthorn differs in type from Shorthorn in other countries.

The objective of this paper is to describe the 150 years of history of the Danish Shorthorn and to analyse the pedigree data of the breed. In the last 10 to 15 years some imports of Shorthorn semen and embryos have been made. In the light of the question of including Danish Shorthorn in the conservation work, it is necessary to estimate the probability of finding genes in the breeding population of 1997 that originate from the old Danish type of Shorthorn, i.e. before 15 years ago.

Presentation of the Danish Shorthorn

Today the Danish Shorthorn is an extensive breed with a good temperament, easy calving and with a good milk yield. Grown bulls reach a live weight of 1 150 kg and cows 650-750 kg (Anon, 1997). The colour varies from red through roan to white, roan being the most common colour. The breed has been very successful when used in crosses with other beef and dairy cattle breeds to produce excellent beef cows. In 1996 there were 37 registered herds and a total of 351 registered purebred Shorthorn cattle (Hansen, 1997).

The Shorthorn originates in England primarily as a result of the work of the Colling brothers. Between 1770 and 1810 the Collings carried out a breeding programme based on the local breeds in Yorkshire (Svendsen, 1906). There is no evidence of how they founded the breed, but several authors point out that Collings must have used inbreeding (Prosch, 1885; Svendsen, 1906). Wright (1922) has one example of inbreeding in the pedigree of a bull from Charles Colling. The bull, Comet had an inbreeding coefficient of 0.469 when the great grandparents are included (Wright, 1922). Originally, the Shorthorn was bred for beef production, but was later split up into three strains: beef Shorthorn, dairy Shorthorn and dual purpose (Christensen, 1944).

In Denmark there was a very successful steer production from the 13th to the 18th century (Hansen & Bønding, 1967). The steers were highly demanded in the German cattle markets, being famous for their tasty meat and large bodies (Hansen & Bønding, 1967). In 1847 a large import of Shorthorn was initiated in order to increase the daily weight gain of the local breeds. During the following few decades the Shorthorn was used so intensively that at least one of the local Danish breeds was declared extinct in 1870 (Frank, 1946), and through repeated upgrading a population of Danish Shorthorn was established. At the beginning of the 20th century the meat production became less profitable than milk production and import of the dairy and dual purpose Shorthorn began in order to form a dual purpose Shorthorn in Denmark (Dyrbye *et al.*, 1950).

In 1906 the first volume of the studbook of Danish Shorthorn was published. All imported purebred Shorthorn of all three strains (beef, dairy and dual purpose) and Danish-bred crosses of a certain standard were included (Christensen, 1944). The imports of Shorthorn continued until the 50's when the interest in the breed declined drastically, because of a non competitive low milk yield and excessive fat content in meat (Lund, 1986). As a consequence, an import of red and white dual purpose breeds from Germany and especially the Dutch Maas-Rijn-Ijssel breed was initiated in order to upgrade the Danish population. This lead to the formation of the Danish Red and White

cattle breed (DRW) in 1962. The studbook of DRW was open for all the red and white crosses as well as the purebred Shorthorn.

According to the annual report "Kvægavlen i Jylland" there was one herd owned by the brothers Lynge that was kept as purebred Shorthorn although the herd was recorded under the Danish Red and White (DRW) during the period of 1963 to 1970 (Anon, 1963-70). During this period the milk yield of DRW increased a little while the milk yield of Lynge's herd declined or remained the same. In 1971 Lynge's herd was recorded in "Årsberetning fra Landsudvalget for Kvæg" (Anon, 1971) as Shorthorn under the name "Old Shorthorn". From then onwards, the number of Shorthorn in Denmark increased and in the 1980's new breeders began to systematically import semen and ately embryos, mainly from England, but also from Canada and New Zealand.

Today the breed has its own breeding organisation: "Danish Shorthorn". A few breeders in the organisation have suggested that the descendants of Lynge's herd should be conserved as an example of the old type of Danish Shorthorn. To determine how much support this suggestion has among the breeders, questionnaires have been sent to 26 of the registered breeders. The questionnaires were prepared according to the basic rules of the questioning technique outlined by Kristensen (1990). Because of the small number of questionnaires the answers will only be commented shortly here. Most of the breeders are part-time farmers and the herds are on average of 5 cows and their offspring. Only a few breeders wanted to support an eventual conservation of the descendants of Lynge's herd and the rest were very keen on improving the qualities of Danish Shorthorn as a beef cattle breed, which is why they imported semen and embryos. Their breeding goal is an extensive breed of beef cattle with easy calvings, lean meat, good temperament and high weight gain.

Materials and Methods

Population data of the breed for the period of 1970 to 1997 was provided by the National Committee of Danish Cattle Husbandry in three data files with 1486, 1096 and 1095 records. Based on the available data a pedigree file with 482 animals was constructed. The animals with unknown parents - the last traceable generation - were defined as base animals of which there was a total number of 72. The identification numbers of the base animals were coded in three groups:

a) imported animals (19);
b) animals of the old type of Danish Shorthorn (21) and
c) animals of a more uncertain origin (32).

The animals in group c may in theory belong to group a or b or they may be of the DRW breed.

The gene dropping method (MacCluer *et al*., 1986) was applied to the pedigree file and repeated 200 times. Gene dropping refers to the assignment of two unique hypothetical alleles at one locus to each of the 72 base animals. The alleles are then dropped through the pedigree according to the laws of Mendel, i.e. no systematic influences on allele frequencies such as selection. The contribution of each base animal to the population of 1997 was computed as the percentage of the alleles in the 1997 population originating from each base animal. The contribution was calculated for each replication and based on the 200 replicates in which the average contribution and the standard deviation were obtained. The probability of the loss of alleles from base animals was computed as the proportion of the 200 replicates of the alleles of the base animals that were completely lost.

The inbreeding coefficient for each animal was computed as proposed by Quaas (1976).

Results

The number of animals in the population under study - animals alive and breeding in 1997 - was 104; 96 cows and 8 bulls (Table 1). The average inbreeding coefficient in the 1997 population was 4.1% ranging from zero to 35.6%. The 1997 population could be traced from one to seven generations back. Consequently, it is not recommendable to estimate the trend of inbreeding based on these data, because estimation of trends in inbreeding should only be based on years in which animals born have sufficient ancestral generations (Te Braake *et al.*, 1994).

population, 13 were found to be underrepresented (contribution ,1.4%) (animals 2, 3, 8 to 13 and 15 to 19). The base animals of the old type contributed to the 1997 population with a minimum of 0.0% (animals 20, 26, 27, 36, 37, 38 and 40) and a maximum of 4.1% (animal 22). The alleles of eight of the base animals of the old type were underrepresented (animals no. 23 ,24, 25; 31; 33, 34, 35 and 39).

The percentage of the replicates where both alleles of an imported animal were lost, ranged from a minimum of 0.0% to a maximum of 60.0%, but only two base animals had more than 50% risk of losing both alleles. In the group of old-type base animals, the alleles were lost in a range of

Table 1. Summary of the Danish Shorthorn pedigree data.

Total number of animals in the pedigree file	482
Total number of animals in the 1997 population [a]	104
Total number of base animals	72
Number of imported base animals	19
Number of base animals of the old type	21
Number of base animals of uncertain origin	32
Maximum number of generations traced	7
Mean inbreeding level in the 1997 population	4.1%
Range of inbreeding coefficient in the 1997 population	0.0% - 35.6%

[a] 96 cows and 8 bulls.

Tables 2 and 3 show the results from the gene dropping. Table 2 has four columns within each group of base animals. The recorded identification numbers of the base animals are shown in the first column in table 2. The second and third columns show the contribution and the standard deviation of each base animal to the 1997 population.

In theory, if all the base animals contribute equally to the 1997 population, the expected contribution of alleles would be 1.4% (1/72). All the imported alleles were present in the 1997 population with a minimum of 0.3% (animal no. 12) and a maximum contribution of 4.8% (animal no. 1). Though all imported base animals contribute to the 1997

0.0% to 100.0% of the replicates. In this group 13 base animals had more than 50% risk of losing both alleles.

The proportionate contribution to the 1997 population of the three groups of base animals is given in table 3. The group of imported base animals contributed with one third of the alleles present in the 1997 population whereas the group of the old type of base animals only contributed with 23%. Of this 23% six animals contributed with 20.2%. The group of base animals of uncertain origin contributed with more than one third of the alleles in the 1997 population, but not all animals in this group were represented.

Table 2. Contribution of each base animal to the population of 1997.

Base animals											
Imported Contribution				Old Danish type Contribution				Uncertain origin Contribution			
Animal	%	S.D.	% lost	Animal	%	S.D.	% lost	Animal	%	S.D.	% lost
1	4.8	0.028	2.0	20	0.0	0.000	100.0	41	5.0	0.028	3.5
2	0.8	0.012	60.0	21	2.3	0.014	9.0	42	0.3	0.008	83.5
3	1.3	0.009	0.0	22	4.1	0.016	0.0	43	1.5	0.016	36.0
4	3.9	0.029	4.0	23	0.2	0.003	74.5	44	4.3	0.030	8.5
5	3.3	0.031	24.0	24	0.2	0.003	62.0	45	6.3	0.035	0.0
6	4.3	0.042	26.0	25	0.5	0.005	47.5	46	2.9	0.014	0.0
7	1.6	0.013	21.0	26	0.0	0.000	100.0	47	0.0	0.000	100.0
8	0.5	0.005	52.5	27	0.0	0.000	100.0	48	1.5	0.016	40.5
9	0.8	0.005	17.0	28	2.7	0.015	4.0	49	0.2	0.003	70.0
10	0.7	0.002	0.0	29	3.4	0.028	9.0	50	0.0	0.001	95.0
11	1.3	0.006	1.0	30	3.7	0.033	6.0	51	0.0	0.000	100.0
12	0.3	0.002	42.5	31	0.2	0.003	67.5	52	3.0	0.014	0.0
13	1.1	0.004	0.0	32	4.0	0.015	0.0	53	3.5	0.033	33.0
14	4.4	0.043	11.0	33	0.2	0.003	64.5	54	0.1	0.003	79.0
15	1.3	0.004	0.0	34	0.2	0.002	52.0	55	0.0	0.000	100.0
16	1.1	0.008	19.5	35	0.1	0.002	73.0	56	0.0	0.000	100.0
17	1.0	0.009	22.0	36	0.0	0.000	100.0	57	0.5	0.005	47.0
18	0.7	0.002	0.0	37	0.0	0.000	100.0	58	1.2	0.014	32.5
19	0.7	0.002	0.0	38	0.0	0.000	100.0	59	0.0	0.000	100.0
				39	0.9	0.003	0.0	60	1.2	0.019	52.5
				40	0.0	0.000	100.0	61	0.0	0.000	100.0
								62	0.0	0.000	100.0
								63	0.1	0.002	83.0
								64	0.0	0.000	100.0
								65	0.0	0.000	100.0
								66	0.8	0.019	72.5
								67	0.7	0.009	44.0
								68	0.6	0.009	59.0
								69	0.0	0.000	100.0
								70	0.8	0.012	59.5
								71	0.2	0.003	60.5
								72	2.0	0.006	0.0

% loss: the proportion of the 200 replicates in which the base animal alleles were completely lost.

Table 3. Contribution of base animal type to the 1997 population.

Base animal type	No.	Sum of contribution, %
Imported	19	33.8
Old Danish	21	22.8
Uncertain	32	36.7

Discussion

The pedigree analysis with the gene dropping method revealed that the old type of Danish Shorthorn is represented by 23% in the 1997 population. Six animals of the old type contributed with as much as 20.2% and alleles of these six animals were found in a minimum of 90% of the replicates. This indicates that alleles of these six animals of the old type with a high probability can be found in the 1997 population and therefore be conserved. Alleles of three animals of the old type were not lost in any of the replicates and consequently with 100% certainty can be found in the 1997 population and be conserved. According to Gandini *et al.* (1994) this type of information from the gene dropping can be used to select animals to be stocked. The information can also be used to select initial sires and dams of sires in a conservation programme, because sire alleles have less risk of being lost in a conservation programme than dam alleles (Trinderup *et al.*, 1998).

If it is decided to conserve the Danish Shorthorn as a closed population, it is worth noticing that the number of breeding females (96) qualifies the breed as being of critical status (<100 females), which is the most vulnerable status according to Bodó (1990a).

The short pedigrees that form the basis of the computation of the average inbreeding coefficient in the 1997 population underestimate the number of inbred animals but give relatively high inbreeding coefficients for inbred animals (Te Braake *et al.*, 1994). The base animals are assumed to be unrelated, which most likely results in an underestimation of the average inbreeding coefficient. According to Te Braake *et al.* (1994) analysis should focus on inbreeding trends, rather than on absolute levels, but as it was pointed out earlier in this paper it is not recommendable to find the inbreeding trend on the basis of these data because of the lack of sufficient generations.

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Conservation and utilisation of the Sahiwal cattle in Kenya

W.B. Muhuyi, I. Lokwaleput & S.N. Ole Sinkeet

Kenya Agricultural Research Institute, National Animal Husbandry Research Centre Naivasha, P.O. Box 25, ***Naivasha****, Kenya*

Summary

Sahiwal cattle are indigenous to Pakistan and India, and were imported to Kenya in 1930s and 1940s. The breed has been developed as a dual-purpose breed and is utilised in smallholder farming systems, beef and dairy ranching in marginal areas of Kenya which form 80% of the country. Conservation efforts include keeping of Sahiwal herds on state farms, individual ranches and the establishment of the Sahiwal semen bank at the Central Artificial Insemination Station at Kabete near Nairobi. Breeding of the Sahiwal has been promoted by the formation of the Sahiwal Breeders Society which has established breed standards for registration of Sahiwal cattle with the Kenya Stud Book.

Resumen

La raza bovina Sahiwal es originaria de Pakistan e India y fue importada en Kenya en los años 1930 y 1940. La raza se ha desarrollado como raza mixta y viene utilizada en pequeñas explotaciones de carne y leche en zonas marginales de Kenya, que representan un 80% del país. Los esfuerzos de conservación incluyen mantener los rebaños de Sahiwal en explotaciones estatales, en ranchos privados y establecer un banco de semen de Sahiwal en la Estación Central de Inseminación Artificial de Kabete, cerca de Nairobi. La mejora de la raza Sahiwal ha sido promovida a través de la creación de la Sociedad de Mejoradores de Sahiwal, que ha establecido los estándares de raza para la registración de la raza Sahiwal en el libro de registro de razas de Kenya.

Key words*: Herd management, Characteristics, Breeding plan, Performance production systems.*

Introduction

The Kenya Sahiwal is a dual-purpose breed which has been bred in Kenya since 1939. The breed originated in Pakistan and India. The Sahiwal breeding stock, mainly bulls, were imported, maintained and used for upgrading indigenous zebu cattle at thirteen livestock improvement centres, namely Ngong, Kabianga, Baraton, Maseno, Sang'alo, Cheborорwa, Machakos, Ndomba, Chemeron, Katumani, Mariakani, Naivasha and Marimba. The first three bulls were imported from Pusa in India. After 1945, 60 Sahiwal bulls and 10 Sahiwal cows were imported from Jahangirabad in Pakistan. Another importation of 15 Sahiwal bulls was from Karnal in India in 1964. In addition to the ten cows, some improved indigenous zebu cows were selected and used as foundation stock in the grading up and multiplication of the Kenya Sahiwal cattle by systematic crossing with imported purebred Sahiwal bulls. By 1962, there were 2 500 Sahiwals in the 13 livestock improvement centres. The latest importation has been of 1 000 doses of semen from six proven Sahiwal bulls from Pakistan in 1991 for use in the Sahiwal stud and other Sahiwal herds in the country.

The National Sahiwal Stud was established at the National Animal Husbandry Research Centre at Naivasha in 1963 because its ecological conditions were suitable for maintaining the Sahiwal Stud. The total area used by the Sahiwal Stud at Naivasha is 3 600 hectares (7 920 acres). The research farm is located to the east of Lake Naivasha in the Rift Valley Province of Kenya.

The climate is characterised by wet and dry seasons. The dry season months are January-March and July-September. The wet season occurs in April-June and October-December. The total annual rainfall is 620 mm and the average maximum and minimum temperatures are 26°C and 8°C, respectively. July is the coldest month. The relative humidity varies from 60 to 75%. There are strong desiccating winds in the dry season.

The natural vegetation at Naivasha consists of Kikuyu grass (*Pennisetum clandestinum*) near Lake Naivasha and star grass (*Cynodon plectostachyum*) with scattered acacia trees.

Objectives

The main objective for the establishment of the Kenya Sahiwal Stud was to improve the breed for milk and meat production in marginal areas. The secondary objectives were to produce semen from proven bulls, to produce breeding stock for Kenya farmers and to conserve and improve the Sahiwal genetic resource.

The purpose of this paper is to present for publication a synthesis of information collected over the years on the improvement effort of the Sahiwal including various methodological approaches, formulation of breed standards, management and performance of the herd at the National Animal Husbandry Research Centre, Naivasha.

Conservation of the Kenya Sahiwal Cattle

Conservation of Sahiwal breed has involved identification, characterisation, preservation, improvement and utilisation in smallholder mixed-farming systems, beef and dairy ranching. Methods of preservation include maintenance of purebred herds on state farms, individual ranches and establishment of a Sahiwal semen bank.

The National Sahiwal Stud at Naivasha is a member of the Sahiwal Cattle Breeders Society of Kenya and the Kenya Stud Book. Sahiwal cattle are inspected by the Inspector of the Sahiwal Cattle Breeders Society before they are registered by the Kenya Stud Book. For cattle to qualify for registration they should meet the breed standards. The Inspector requires detailed pedigree and performance records on each animal during inspection.

Characteristics

The Sahiwals are heavily built, and the colour ranges from reddish brown to chestnut. It has a typical head shape. In profile the brow slopes back to the poll and the line from brow to muzzle is straight and long. The hump is in the cervico-thoracic position. Ears are long and drooping and set behind and level with the eyes. Breed standards of Kenya Sahiwal Cattle are reported in table 1.

Disqualification

Animals were disqualified for any extreme manifestation of undesirable characters or for hereditary defects that occur in cattle such as Hernia, Cryptorchidism, Malformed genitalia, excessive size of teats in cows.

Table 1. Breed standards of Kenya Sahiwal Cattle.

Item	Description
Coat colour	**Desirable:** Reddish brown to chestnut. **Permissible:** Slightly mottled white spots on underline.
Hair	Short, straight and smooth.
Skin	Pigmented.
Hide	Moderately thick, loose and pliable.
Head	**Bull**: Masculine, alert, straight and long. **Cow:** Feminine, calm but alert.
Horns	Bulls and cows should be de-horned.
Ears	Long, drooping and developed crest and clearly defined muscles. **Cow:** Lean and flat or rounded.
Hump	Well developed in cervico-thoracic position.
Shoulders	**Bull:** Neat attachment, free-moving ,well-muscled. **Cow:** Neat free moving, lean but not heavily -muscled.
Brisket	Broad with skin fold clearly defined over brisket.
Heart girth	**Bull:** Not deep, broad but fairly full. **Cow:** Not deep, broad but relatively lean with feminine quarters.
Backline	Backline forward of sacrum should be both broad and level.
Loin	**Bull:** Prominent. **Cow:** Smooth not pronounced.
Ribs	Well-sprung, forming an angle with the vertebral column.
Hip bones	**Bull:** Narrow and angular. **Cow:** Narrow but free from hard lumps of fat.
Rump	Broad, slightly rounded on top, fairly long with moderate slope, front to rear.
Hind quarters and thigh	Broad, long , flat when viewed from the rear. Muscles clearly defined in bulls. Smooth in the case of cows.
Tail and tail setting	Smooth insertion well to the rear, the tail must hang down perpendicularly and must have a well developed switch.
Legs and hooves	Well-set, strong sound legs and feet, darkly pigmented hooves.
Udder and teats	Well-attached medium-sized milky udder, teats not too large or small and should be well-pigmented.
Sheaths	Normal, neatly attached, well-closed sheath opening with a good sphincter.
Testicles	Good size and held in scrotum with a clearly defined neck to scrotum.
Body conformation	**Bulls**: Bull symmetrically balanced, defined muscles. Deep in front but well–muscled in hind quarters. Good length of body, well-sprung ribs, good strong legs. **Cows**: Lean in neck and shoulders, well-developed hind quarters. Slightly drooping rump. Good length of body, well-sprung ribs and good strong legs.
Size	Large for age, fast gaining, good feed converters.
Disposition	Calm and tractable. (temperament)
Functional efficiency (fertility)	**Bull**: Masculine, virile, and high libido. **Cow**: Feminine, regular calving and calving with ease.

Table 2. Herd structure, size and % of total herd at Naivasha Research Centre (1996).

	Herd structure and size (1996)	% of total herd
i) Milk herd	230	14.5
ii) Dry cows	130	8.2
iii) Heifers (9-36 months)	398	25.1
iv) Weaners		
Males	100	6.3
Females	121	7.6
v) Calves		
Males	140	8.8
Females	150	9.4
vi) Bulls	200	12.6
and Steers	120	7.5
Total	1 589	100

Disqualification also applied when there was an undershot or overshot jaw, straight hind legs, coarse, woolly coat and any symptoms of sub fertility or lack of functional efficiency.

Herd Management at Naivasha Research Centre

The Sahiwal herd was grouped as follows:

i) Breeding cow herd consists of lactating and dry cows.
ii) The bull herd consists of young bulls for progeny testing and older bulls awaiting progeny test results.
iii) Young stock consists of calves and weaners.

Herd structure, size and % of total herd at Naivasha Research Centre (1996) are reported in table 2.

Calf rearing

The breeding pattern was such that calvings occur in all months of the year, although not in equal proportions. Of the total calvings, 70 per cent occur between March-October, while 30 per cent occur in January-February and November-December. Calves were separated from their dams immediately after parturition, weighed and nipple-fed colostrum in the first week and thereafter whole milk at a rate of 10% of the body weight. Calves were weaned at 12 weeks at an average weight of 55kg.

Weaner stock (55 to 125kg)

Weaners were rotationally grazed on natural pastures in paddocks which were adequately supplied with water. They were provided with mineral licks *ad libitum* when available. At 4 months of age, males from below-average yielding cows and test bulls were castrated and disposed of as fattening steers. They were then branded at 8 months of age and separated by sex.

Heifers (9-36 months)

Heifers joined the dry cow herd and were weighed monthly up to 27 months of age. They were randomly assigned to test bulls and those that had attained 270 kg at 27 months of age were inseminated.

Young bulls (9-24 months)

Young bulls at 9 months of age were transferred to the bull herd. Weighing was done monthly up to 24 months of age. At this age, they were selected for progeny testing on the basis of an index computed from the breeding values of the sire, dam and growth rate of the young bull. Out of 75 bulls from the elite herd, 15 bulls were selected to form a team for progeny testing and their semen was collected and stored at the Central Artificial Insemination Station(C.A.I.S.), Kabete. Bulls were further selected on semen quality and as a result of semen evaluation, 10 of them were finally selected for progeny testing.

Bulls over 24 months

Bulls selected for progeny testing were maintained for a period of 6-7 years when progeny test results were available. From the ten bulls, the best two bulls in terms of milk production of their daughters were selected and taken to C.A.I.S., Kabete, for semen production. Semen from proven Sahiwal bulls was used locally and surplus was exported.

Lactating cows

Cows were hand milked twice a day in the morning at 6-8 hours and 14-16 hours. As a result of selection for good temperament, Sahiwal cows at Naivasha are milked in the absence of calves and let down milk without the calf suckling. Sahiwal cows are capable of producing milk for a lactation period of 290-305 days.

Grazing management

The Sahiwal herds were rotationally grazed in the paddocks which were adequately supplied with water from the river or borehole. Mineral licks were provided *ad libitum*. Since Sahiwals are being developed for marginal areas with limited feed resources, it was the policy of the Stud not to supplement cows with dairy meal. However, farmers keeping Sahiwals for milk production provided concentrate feed and cows responded favourably by yielding more milk.

Health management

With acaricide solution, dipping was done once a week for the bull herd, milk herd, dry herd, maternity herd (cows 3 months to parturition), and weaner stock. Calves were sprayed with a spray race once a week. The frequency of dipping was determined by the tick load in the grazing area which was in turn influenced by seasonal distribution of rainfall. Routine vaccinations against rinderpest were done after one year of age and once in the animal's lifetime. Foot and mouth disease and anthrax vaccinations were given twice a year. Young stock were dewormed regularly after 3 months and as was necessary depending on the helminth faecal egg count.

Breeding

Sahiwal cows were inseminated with deep-frozen semen from proven Sahiwal bulls. Heifers and first calvers formed the test herd and were inseminated with semen from young bulls selected for progeny testing. Cows were observed for oestrus signs at grazing and milking time. Cows showing oestrus signs were inseminated 12 hours after onset of oestrus. Cows displaying irregular oestrus were examined by an on-station veterinarian and treated.
Pregnancy diagnosis was done by rectal palpation 2-3 months post-service. Cows that were not pregnant were scheduled for rebreeding or were disposed of if they had fertility problems. Pregnant heifers and cows were moved to the maternity paddocks in the last 3 months of pregnancy. Cows were then closely observed for signs of parturition. Dystocia was not common in the Sahiwal herd, perhaps because calves were small, weighing on average 20 kg. After parturition, cows were weighed immediately within 24 hours. Cows resumed oestrus activity 45 days later and were ready for breeding after 70 days when uterine involution was complete .

Breeding Plan

Mason (1965) designed a breeding scheme which has been implemented for genetic improvement of milk yield and growth rate in the nucleus closed herd (Figure 1).
The nucleus breeding scheme was found an appropriate system of organisation for testing, selection and dissemination of genetic progress in view of the poorly developed infrastructure in the marginal areas for artificial insemination and field recording.

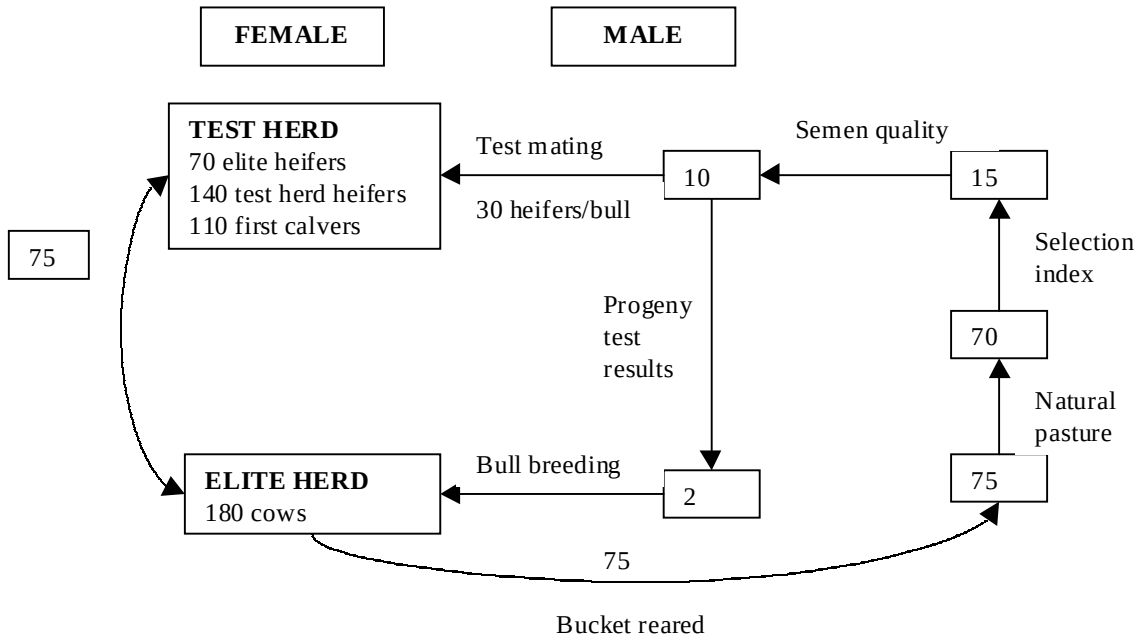

Figure 1. Breeding plan at the National Sahiwal stud.

In the nucleus herd, detailed recording of performance traits was carried out and genetically superior animals were identified and selected for breeding in the nucleus herd and in the commercial herds.

Selection and breeding procedures involved:

i) Breeding elite cows to proven bulls to produce young bulls for progeny testing within the nucleus closed herd.
ii) Young bulls for progeny testing being selected on the basis of pedigree information and individual growth rate.
iii) Bull dams selected from the top 5-6% of the elite herd.
iv) Cows selected within lactation on the basis of individual milk yield and low yielders being culled and disposed of.

Performance of the Sahiwal Cattle

Lactation milk yield

The mean lactation milk yield was 1 574 ± 575.8 kg (M±SD) with a coefficient of variation of 36.6% (Muhuyi, 1997). The heritability estimated by paternal half-sib analysis was 0.127 ± 0.04.The additive genetic variation was low, perhaps because the nucleus herd has been bred as a closed herd for 35 years.

Lactation length

The mean lactation length was 293 ± 37.5 days with a coefficient of variation of 12.8%.The phenotypic correlation between lactation milk yield and lactation length was 0.47, indicating that there is a significant relationship between milk yield and lactation length in the Sahiwal. This is

Figure 2. Grazing sahiwal herd.

unlike the cattle in temperate areas where there is no relationship between milk yield and lactation length.

Age at first calving

The mean age at first calving was 40.1 ± 3.8 months with a coefficient of variation of 9.5%. Analysis of variance showed that sire effects influenced age at first calving. The heritability estimate of age at first calving was 0.20 ± 0.097 and this indicates that selection for growth rate can result in improvement of age at first calving. The average lifetime of the Sahiwal is 98 months and the productive life is 58 months in which it produces 4.2 calves.

Services per conception

The mean services per conception were 2.0±1.5 with a coefficient of variation of 74.6%. The heritability estimate for services per conception was 0.038 ± 0.028. Although the trait is of low heritability, it was possible to evaluate sires using a large number of daughter records. This was possible in a cooperative breeding scheme involving Sahiwal herds in other ranches.

Days open

This is the period from calving to successful conception. The mean days open was 151 ± 90.6 days with a coefficient of variation of 59.9%. The phenotypic correlation of days open and calving interval was high and positive (r=99) indicating that the two measures of fertility refer to the same trait.

Gestation length

This is the period from conception to normal delivery of a calf. The mean gestation length is 287 ± 5.1 days with a coefficient of variation of 1.8%. Heritability estimate was 0.10 ± 0.03 and repeatability was 0.18.

Figure 3. Herding Sahiwal herd.

Figure 4. Milking herd.

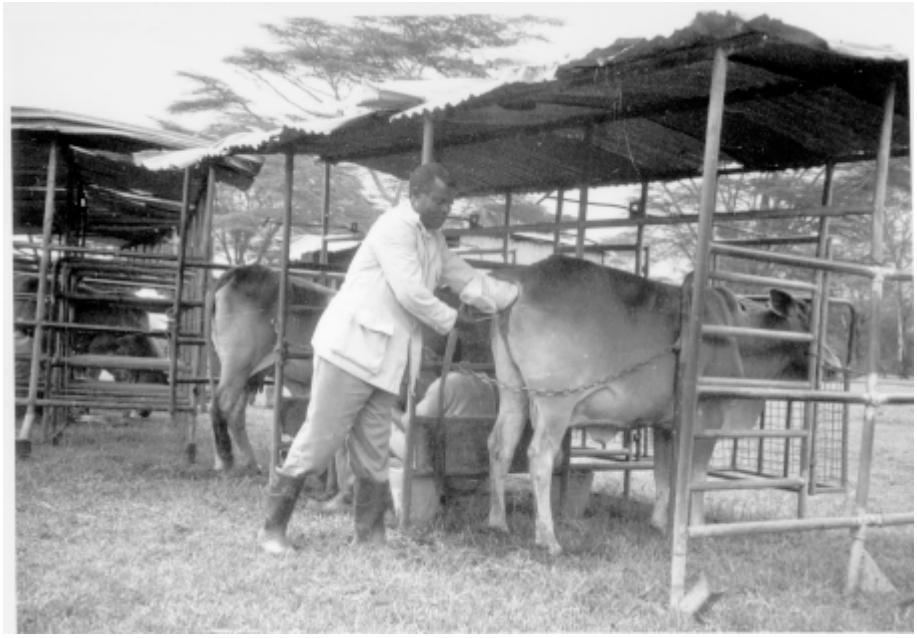

Figure 5. Artificial insemination of Sahiwal cow.

Calving interval

Calving interval is the period in days between two consecutive parturitions and is derived from the previous date of calving and the current date of calving. The mean calving interval of the Sahiwal was 437.75 ± 90.8 days with a coefficient of variation of 20.7%.

Growth characters

The mean birth weight of Sahiwal male calves was 21.4 ± 0.17 (M ± SE) and for female calves 21.0 ± 0.33 (Mwandotto, 1985). Male calves are heavier than females by 0.47 kg. The mean weaning weight of Sahiwal male calves was 56.29 ± 0.20 kg and for female calves 56.25 ± 0.20 kg.

The pre-weaning daily gain of Sahiwal males was 300gm / day and for females 208 gm / day. Growth rate to 125 kg was 511 ± 4.5 gm / day and 470±3.8 g / day for males and females, respectively. Weight at first service of Sahiwal heifers was 270 kg at an age of 27 months. The mature cow weight was 425 kg and mature weight for males was 500 kg.

Survival rates

Survival rates in the Sahiwal herd vary with sex and age. Pre-weaning survival rates for males and females were 78.1 ± 12.5% and 78.4 ± 10.9% respectively. Post-weaning survival rates for males and females were 95.5% and 96.4% respectively. Mortality rates were relatively high in the pre-weaning stage for both sexes and these were attributed to still birth, abortions, pneumonia, diarrhoea, starvation and accidents. The major causes of losses among mature stock were tick-borne diseases, mainly east coast fever and anaplasmosis.

Production Systems

The Sahiwal breed is utilised in smallholder mixed farming, dairy ranching and beef ranching to produce milk, meat, manure and draft power.

Smallholder mixed farming is practised in sub-humid areas in agro-ecological zone III at an altitude of 1 800-2 100 metres above sea level with annual rainfall of 750-1 000 mm. The natural vegetation consists of evergreen

and semi-evergreen bushland, combretum woodland and savannah. In this agro-ecological zone, population pressure is relatively dense where soils and topography are suitable for agriculture.

Average farm size is small varying from 1 hectare to 5 hectares. Mixed farming is practised including dairy farming, food and crop production. The average herd size is 5 head of cattle. Sahiwal and its crossbreds are managed under zero-grazing and semi-zero grazing conditions. Cattle are fed Napier grass, crop residues and grazed on natural and improved pastures. Cows are supplemented with dairy meal and mineral licks. The average milk yield of the Sahiwal on smallholder farms is 2 097 ± 687.0 kg per lactation.

Dairy ranching is practised in highlands, sub-humid and semi-arid areas in agro-ecological zones III and IV with relatively low annual rainfall of 600-800 mm. Average farm size is between 500-1 000 hectares. Breed types used are Sahiwals and their crossbreds with exotic dairy breeds. Average herd size is 200 head of cattle. Cattle are extensively grazed on natural and improved pastures. Milking cows are supplemented with dairy meal and mineral licks. Infrastructure is well developed to facilitate marketing of milk, dairy products and surplus cattle.

Beef ranching is practised in semi-arid areas in agro-ecological zone IV with annual rainfall of 400-700 mm. Natural vegetation is mainly dry transitional combretum, acacia woodland and savannah. Average farm size is 1 000-5 000 hectares. Meat production is based on Sahiwal and Boran. The average herd size is 300 head of cattle. Cattle are extensively grazed and supplemented with concentrate and mineral licks.

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La Chevre Creole de Guadeloupe (f.w.i.): une ressource génétique importante pour les Tropiques humides

G. Alexandre, G. Aumont, N. Mandonnet & M. Navès

Unité de Recherches Zootechniques, INRA Antilles-Guyane, Domaine Duclos, ***Petit-Bourg*** *97170, Guadeloupe, French West Indies*

Résumé

Cette étude présente une synthèse des travaux menés sur l'évaluation des performances zootechniques des caprins Créoles à viande de Guadeloupe. Ce génotype rustique, de petit format, présente de grandes qualités reproductives et maternelles avec 90% de fertilité, 225% de prolificité et une viabilité naissance-sevrage de 78%. Les performances post-sevrage varient du simple au double selon les conditions d'élevage. Une grande souplesse d'exploitation associée à de fortes capacités productives, ainsi qu'à un potentiel d'adaptation, expliquent le succès de cet élevage aux Antilles. La chèvre Créole peut être sélectionnée sur ses performances d'élevage, de croissance et de résistance au parasitisme gastro-intestinal ou encore peut être valorisée comme souche maternelle pour des croisements possibles.

Summary

This study is a synthesis of the different works carried out on the assessment of the performances of Guadeloupe's Creole meat goat. This local, small-sized genotype has exceptional reproductive and mothering abilities with a fertility of 90%, a prolificacy of 225% and a birth-weaning viability of 78%. The post-weaning performances may double depending on the breeding conditions. A wide breeding flexibility associated with high reproductive abilities, as well as an adaptation potential explain the success of this breeding in the West Indies. The Creole goat may be selected either for its breeding, growth and gastro-intestinal parasitism resistance performances, or also may be valorised as a maternal strain for possible crossbreeding.

Key words*: Creole goat, Reproduction, Growth, Genetic parameters, Carcass, Diseases.*

Introduction

Dans la zone caraïbe les caprins sont principalement élevés pour la production de viande. Les systèmes d'élevage sont extensifs, basés sur l'exploitation des ressources naturelles et aboutissent à des productions animales faibles (Devendra & Mc Leroy 1982). Alors même que l'élevage caprin est important pour assurer la durabilité des petites exploitations agricoles, peu d'études sont menées pour son amélioration. En particulier, les travaux sur la détermination du potentiel de production des populations locales restent limités.

En Guadeloupe, petite île de la Caraïbe (1 700 km^2), la population caprine locale s'élève à 35 000 têtes. Ceci représente 10 chèvres pour 100 habitants et est très similaire du ratio calculé en Inde (FAO 1993), pays très réputé pour l'élevage caprin. Des recherches ont été menées depuis plus de 20 ans sur la production de la chèvre Créole élevée au pâturage à l'Unité de Recherches Zootechniques de l'INRA. Cet article présente une synthèse des performances zootechniques de cette race, incluant les résultats de reproduction, de mortalité, de

croissance ainsi que des caractéristiques de carcasse. Par ailleurs, les principales pathologies sont décrites.

Animaux et Conduite

L'élevage expérimental de l'INRA est situé dans la zone la plus sèche de la Guadeloupe. Le climat est de type tropical humide et présente une saison sèche marquée (6 mois avec une précipitation inférieure à 70 mm / mois). L'effectif du troupeau expérimental a varié de 50 à 220 chèvres reproductrices de 1973 à 1996 (Tableau 1). Au cours de ces années la trajectoire d'évolution du troupeau a surtout été marquée par les différents programmes scientifiques qui y ont été rattachés (physiologie de la reproduction, allaitement et élevage des jeunes, résistance génétique aux helminthes et systèmes de pâturage). Cependant, les modes de conduite se sont stabilisées depuis les années 80, quand le troupeau caprin a pris son véritable essor (Tableau 1). Les relevés réguliers du contrôle de performances du troupeau expérimental ont permis la constitution de différentes banques de données qui ont fait l'objet de différentes analyses. Une synthèse est présentée sur les résultats du troupeau de 1980 à 1996 (Figure 1).

Origine et situation actuelle de la chèvre Créole

La population locale s'est constituée à partir d'importations d'animaux d'origines diverses (Europe, Afrique et Inde) (Naves *et al.* 1998). Elle reçoit très vite l'appellation de chèvre créole comme dans de nombreuses zones de la Caraïbe (Devendra & Mc Leroy 1982; Creole Goat , Indigenous Local goat) et d'Amérique Latine (*Cabra criolla*). Ces races ont été peu étudiées et restent non décrites

Figure 1. Fréquence de distribution des différents rangs de mise-bas des chèvres créoles de l'INRA de 1980 à 1996 (n = 2830 mises-bas).

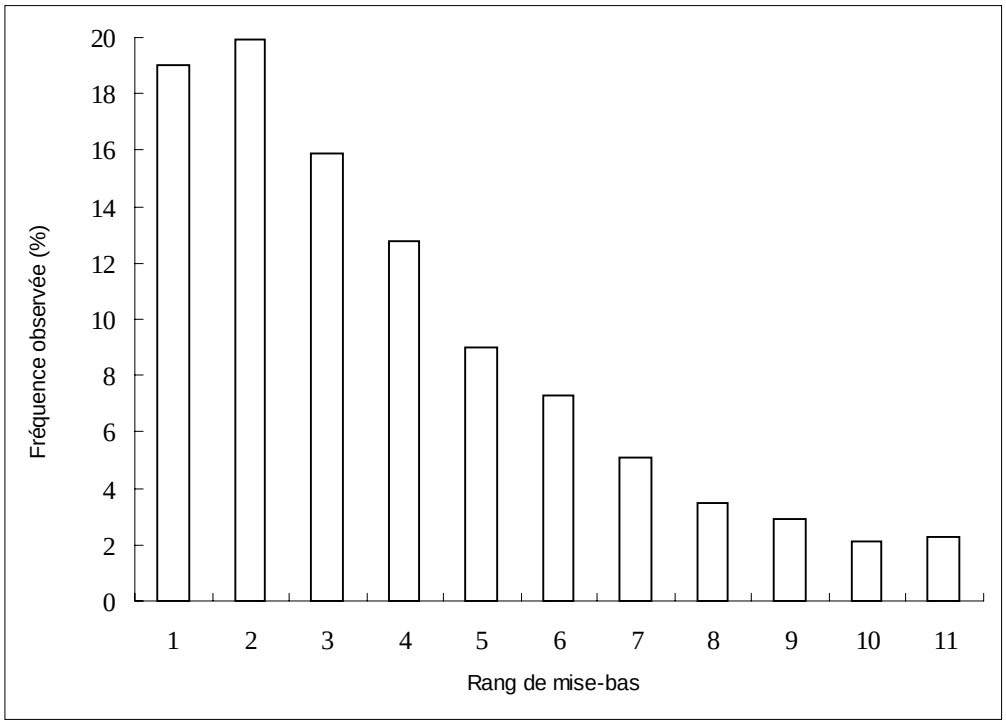

Figure 2. Production laitière journalière de la chèvre Créole de Guadeloupe (F.W.I.) selon la taille de portée, données corrigées pour le niveau d'alimentation et le rang de mise-bas: cercles: taille de portée = 1; carrés: taille de portée = 2.

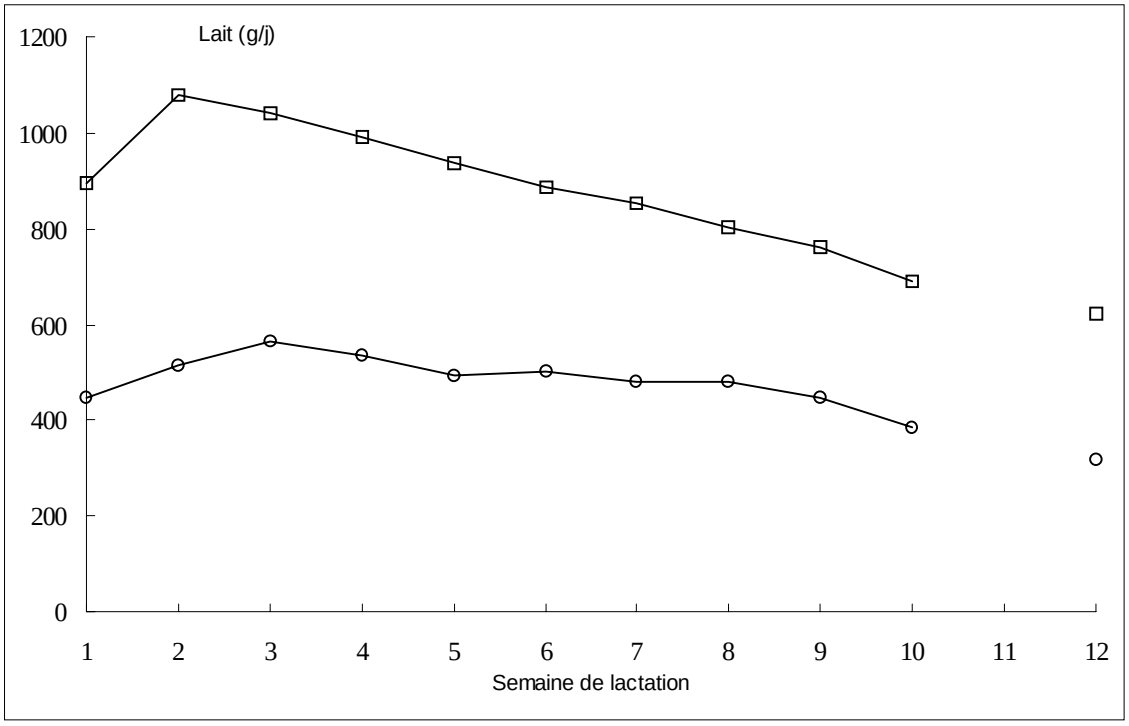

Figure 3. Mâle adulte de chèvre Créole en Guadeloupe.

Tableau 1. Principales caractéristiques des modes de conduite du troupeau caprin Créole du domaine de Gardel INRA en Guadeloupe depuis plus de 20 ans.

Année	Effectif[a]	Reproduction	Alimentation[b]		Irrigation	Prophylaxie
			des mères	des jeunes pré-sevrage		
1973 à 1975	50	Mâle en	Inconnue	Inconnue	Non	Inconnue
1976 à 1978	50	permanence.	Non	Non	Non	Inconnue
1979 à 1980	70	Effet	Non	Non	Non	Régulière [d]
1981 à 1982	100	mâle (EM).	Oui [c]	Non	Non	Régulière [d]
1983 à 1984	100	EM avec	Oui [c]	Non	Non	Régulière [d]
1985 à 1986	120	lutte	Oui [c]	Oui [c]	Oui	Régulière [d]
1987 à 1988	120	en	Oui [c]	Oui [c]	Oui	Régulière [d]
1989 à 1990	150	mains.	Oui [c]	Oui [c]	Oui	Régulière [d]
1990 à 1992	150	EM avec	Oui [c]	Oui [c]	Oui	Régulière [d]
1993 à 1994	180	lutte en	Oui [c]	Oui [c]	Oui	Régulière et
1995 à 1996	220	lots.	Oui [c]	Oui [c]	Oui	contrôlée [e]

a) Effectif des chèvres reproductrices;
b) alimentation: apport ou pas de concentrés;
c) oui: niveaux de concentrés variables selon expérimentation (0.17 à 0.43 UFL / mère; *ad libitum* ou non p les jeunes sous la mère de 30 jours d'âge au sevrage);
d) prophylaxie régulière: détiquage de tout le troupeau tous les 15 jours; déparasitage tous les mois chez jeune et tous les 2 mois chez l'adulte;
e) déparasitage allégé car contrôlé selon le niveau d'infestation parasitaire.

(non-descript ou " sem raza definida ", nom d'une des races locales du Brésil). La chèvre Créole , désormais bien typée du point de vue des marqueurs génétiques par Pepin (1994) est un génotype intermédiaire entre les races européennes et africaines.

La couleur prédominante de la robe est le noir (photo du bouc, figure 3), néanmoins quelques combinaisons de couleurs (noir, fauve et gris, figure 4) sont observées (figure 5, du troupeau allaitant). Selon la base de données nationale française (BRG, 1998) , les caractéristiques de format sont: poids vif adulte moyen 28 kg pour la femelle et 38 kg pour le mâle; hauteur moyenne au garrot de 51 cm et 62 cm, respectivement.

Principales conditions d'élevage

La reproduction était conduite selon un rythme semi-intensif de 3 mises-bas en 2 ans avec l'emploi de l'effet mâle durant un mois de lutte. Trois saisons de mise-bas ont été définies pour le troupeau: durant la saison sèche (mi-mars), durant la saison intermédiaire (mi-juillet) et durant la saison humide (mi-novembre). Les chevreaux étaient élevés sous la mère jusqu'à l'âge du sevrage qui a varié de 75 à 85 jours d'âge.

Les animaux étaient élevés sur pâturage de *Digitaria decumbens* toute l'année. Les parcelles étaient irriguées, fertilisées et conduites en rotation. La charge animale moyen a varié de 50 à 95 mères / ha. Les

Figure 4. Haute productivité à la mise bas d'un troupeau de chèvre Créole allaitantes en Guadeloupe.

chèvres étaient complémentées (différents niveaux) selon leur stade physiologique. Après le sevrage, chevreaux mâles et femelles étaient séparés. Les différentes bandes étaient conduites sur pâturage seul (même conduite) à raison de 1 200 kg PV / ha / an durant 8 mois d'engraissement.

Les animaux étaient régulièrement détiqués (2 fois / mois) et déparasités (1 fois / mois pour les jeunes et 1 fois tous les 2 mois pour les adultes).

Performances de Reproduction

Paramètres principaux

La chèvre Créole manifeste une activité sexuelle continue tout au long de l'année (Chemineau *et al.* 1991). Chez la femelle adulte en l'absence de gestation, les ovulations et les chaleurs se succèdent toute l'année sans interruption: plus de 80% des femelles sont en activité ovulatoire. L'apparition de la puberté est précoce: à 190 jours et à 11,4 kg PV chez la chevrette. La reprise de l'activité sexuelle post-partum, bien que dépendante de la saison de mise-bas et du nombre de jeunes allaités, est rapide: 2 mois après la mise-bas pour plus de 50% des femelles cycliques. Pour cette race non saisonnée, les taux de saillie et de fertilité sont toujours supérieurs à 90% en moyenne sur une période de 15 ans (Alexandre *et al.* 1997a). La taille de protée (TP) est de 2,28 chevreaux par mise-bas. Plus de 80% des femelles mettant bas ont une TP de plus de 2 chevreaux nés vivants et 95% des femelles n'ont aucun chevreau mort. La prolificité augmente (50%) avec le rang de mise-bas de la 1ère à la 5ème mise-bas (Tableau 1). L'âge à la première mise-bas et l'intervalle moyen entre mises-bas sont de 17,2 mois et 8,5 mois , respectivement. La reproduction «plastique» de cette race, associée à des taux de fertilité et de prolificité élevés ainsi qu'à de bonnes qualités maternelles, la classe parmi les meilleures chèvres productrices de la zone intertropicale (Devendra & Mc Leroy 1982, Chemineau *et al.* 1991, Alexandre *et al.* 1997a).

Tableau 2. Taux de prolificité (nombre de chevreaux nés par mise-bas) et de mortalité (pour cent) de la chè Créole de Guadeloupe : effets des rangs de mise-bas et de la saison de mise-bas.

Variable	Rang de mise-bas					Saison de mise-bas*		
	1	2	3	4	=5	SS	SI	SH
Prolificité	1,74[a]	1,96[b]	2,21[c]	2,33[d]	2,37[d]	2,15[a]	2,38[b]	2,35[c]
Taux de mortalité								
0-15 j	20,2[a]	5,7[b]	7,8[c]	8,4[c]	6,5[d]	3,7[a]	6,4[b]	14,3[c]
0-75 j	25,3[a]	9,8[b]	14,6[c]	15,4[c]	12,7[d]	8,1[a]	12,4[b]	20,1[c]

* SS: saison sèche, SI: saison intermédiaire, SH: saison humide (définies dans le texte);
[a, b, c, d]: les valeurs présentant des exposants différents diffèrent significativement (P< 0,01).

Tableau 3 . Performances de croissance pré-sevrage de la chèvre Créole de Guadeloupe : effets de la taille de portée, du sexe et de la saison de naissance sur les poids vif (kg) à la naissance et à âge type de 10, 30 et 70 jour , sur le gain moyen quotidien (GMQ, g/J), et sur les taux de mortalité (pour cent).

Variable	Taille de portée			Sexe		Saison de mise-bas*		
	Simple	Double	≥2	Mâle	Femelle	SS	SI	SH
Poids vif								
A la naissance	2,16[a]	1,84[b]	1,51[c]	1,84[a]	1,66[b]	1,74	1,78	1,74
A 10 jours	3,10[a]	2,81[b]	2,43[c]	2,74[a]	2,58[b]	2,62	2,64	2,62
A 30 jours	5,32[a]	4,53[b]	3,91[c]	4,63[a]	4,21[b]	4,44[a]	4,43[a]	4,29[b]
A 70 jours	8,09[a]	6,87[b]	6,41[c]	7,28[a]	6,57[b]	7,19[a]	7,24[a]	6,82[b]
Au sevrage	9,03[a]	7,75[b]	7,31[c]	8,21[a]	7,53[b]	7,99[a]	7,97[a]	7,71[b]
GMQ **								
GMQ 10-30	107[a]	85[b]	78[c]	91[a]	86[b]	91[a]	90[a]	84[b]
GMQ 30-70	77[a]	63[b]	59[c]	73[a]	65[b]	72[a]	73[a]	65[b]
GMQ N-S***	84[a]	70[b]	58[c]	83[a]	76[b]	82[a]	81[a]	75[b]
Taux de mortalité								
0-15j	1,1[a]	6,5[b]	14,2[c]	9,8[a]	6,4[b]			
0 -75j	3,5[a]	10,5[b]	18,5[c]	16,4[a]	10,8[b]			

* SS: saison sèche, SI: saison intermédiaire, SH: saison humide (définies dans le texte);
** GMQ: Gain Moyen Quotidien pour les différentes périodes, ajusté pour le poids de naissance;
*** N-S: entre la naissance et le sevrage,

Taux de mortalité

Le taux de mortalité pré-sevrage moyen atteint 22%, et 16% intervient en début d'allaitement, sans doute à cause du niveau de production laitière. Les principales sources de variation analysées (Alexandre *et al.* 1997a) sont la taille de portée, le sexe et la saison de naissance du chevreau et le rang de mise-bas de la mère (Tableau 2 et Tableau 3). Les différents niveaux observés sont beaucoup plus faibles que ceux (jusqu'à 50% de mortalité) reportés par Devendra & Mc Leroy en 1982, Alexandre en 1987, et Aumont *et al.* en 1997. Par ailleurs, les effets dus à la saison et au sexe - les taux de mortalité sont plus élevés durant la saison humide d'élevage et pour les mâles- seraient principalement liés aux incidences du parasitisme gastro-intestinal (voir plus bas, Aumont *et al.* 1997).

Performances de lactation

Après correction pour tous les facteurs de variation (niveau de complémentation, rang de mise-bas et taille de portée) la production laitière moyenne est de 792 206 g/j. Les courbes de lactation (Figure 2) sont caractérisées par un pic de lactation précoce (à la deuxième semaine de lactation) et de faible amplitude (550 g/j et 1 020 g/j pour des femelles allaitant des simples et des doubles, respectivement). Les niveaux nutritionnels affectent à la fois les rendements laitiers et le taux butyreux ; ce dernier avoisine 50 g de lipides/kg de lait. A partir de ces résultats, la chèvre Créole apparaît comme une bonne productrice laitière comparativement à toutes les autres races caprines à viande (Alexandre *et al* 1997a).

Performances de Croissance

Croissance pré-sevrage

Le gain moyen quotidien de la naissance au sevrage (GMQ), après correction pour les principaux facteurs de variation, est de 75 ± 15 g/j. Les sources de variation analysées (Alexandre *et al* 1997a,) sont la taille de portée, le sexe et la saison de naissance du chevreau et le rang de mise-bas de la mère (Tableau 3). Les poids à la naissance (PN) et au sevrage (PS), réalisé à 82 ± 15 jours, sont 1,73 ± 0,34 kg et 7,75 ± 1,76 kg. Les PN et PS varient selon la taille de portée et le sexe: 15% de différence entre chevreaux simple et double et 10 à 8% de variation entre mâle et femelle. Les GMQ 10-30j (de 10 à 30 jours) et GMQ 30-70 sont de 84,3 ± 25,9 g et 65,7 ± 24,0 g, respectivement. En conclusion, dans de bonnes conditions d'élevage, la chèvre Créole présente des croissances similaires ou supérieures à celles observées pour les autres races tropicales (Devendra & Mc Leroy 1982, Alexandre *et al* 1997a).

Les héritabilités (Tableau 4) pour l'effet direct (h^2_D) varient de 0,129 à 0,227 pour le poids vif à la naissance ou les poids âge type avec de fortes corrélations génétiques entre ces caractères (Mandonnet *et al*. 1997a). Les héritabilités (h^2_D) pour les GMQ vont de 0,087 ± 0,141 selon les différents âges. L'effet maternel (h^2_M) varie de 0,251 à 0,476 pour les poids vifs et de 0,156 à 0,259 pour les GMQ. L'héritabilité h^2_D pour la taille de portée est de 0,069 et la répétabilité R est de 0,276. Il convient de poursuivre les analyses pour étudier les relations entre les effets directs et maternels. Cependant, ces paramètres peuvent être dores et déjà utilisés dans le schéma d'amélioration génétique de la chèvre Créole (Mandonnet *et al.* 1997b).

Performances post-sevrage

Différents modes de pâturage ont été testés pour un engraissement durant la période de 3 à 11 mois (Alexandre *et al.* 1997b), le GMQ post-sevrage du chevreau Créole atteint, en moyenne, 36,3 g pour le mâle et 37,2 g pour la femelle. Pour les chevreaux mâles abattus à un âge et un poids moyen de 12 mois et 18 kg PV, le rendement de carcasse moyen avoisine 54% (Alexandre 1987). Par ailleurs, un engraissement plus intensif a été réalisé avec des niveaux de complémentation adéquats: le

Tableau 4. Paramètres génétiques pour différents caractères de croissance de la chèvre Créole de Guadeloupe (FWI): poids vif (PV) à la naissance et à âge type 10, 30 et 70 jours et gain moyen quotidien (GMQ) pour les périodes correspondantes : héritabilités pour les effets directs h^2_D et héritabilités pour les effets maternels h^2_M.

Caractère	h^2_D	h^2_M	R
Poids de naissance	0.227	0.426	0.345
PV10	0.196	0.302	0.367
PV 30	0.170	0.251	0.345
PV 70	0.129	0.309	0.284
GMQ 0-10	0.141	0.157	0.225
GMQ 10-30 (A)	0.128	0.156	0.239
GMQ 30-70 (B)	0.087	0.217	0.145
GMQ 10-70	0.117	0.259	0.222

Rg_{AB} = 0.801; corrélation génétique. Rp_{AB} = 0.701; corrélation phénotypique

chevreau mâle croît de 85 g/j durant 5,5 mois (Chemineau *et al.* 1984). Il apparaît que le système d'élevage strictement à l'herbe ne permet d'atteindre que la moitié du potentiel de croissance du caprin Créole, mais cette conclusion s'applique aussi aux autres ruminants élevés au pâturage (Humphreys 1990).

Le rendement de carcasse atteint 57%. La composition de la carcasse, estimée par la dissection de l'épaule, est de 73,5% de muscle, 10% de gras et 16,5% d'os (Alexandre 1987). Ces résultats concordent avec les meilleures données reportées par Devendra et Mc Leroy en 1982.

Principales Pathologies

Parasitisme gastro-intestinal

Des études menées en fermes et en station montrent que les strongyloses digestives sont les maladies les plus importantes des petits ruminants dans les petites Antilles (Aumont *et al.* 1997). Le nématode *Haemonchus contortus*, la cestode *Moniezia*,sp. et le protozoaire *Eimeria* spp. sont les principaux parasites digestifs. Les prévalences de *Haemonchus* spp. et de *Trichostrongylus* spp. varient de 80 à 100%. Les incidences de ces vers sont supérieurs à 60% par mois. Les strongyloses induisent plus de 80% de la mortalité totale avant sevrage, i.e. 40% de taux de mortalité. Les cas de résistance du parasite *Haemonchus contortus* aux produits anthelmintiques (benzimidazoles) sont communs. Les principales sources de variation du risque d'infestation sont l'irrigation, le climat et la sensibilité de l'animal. Les systèmes de pâturage intensifs basés sur l'irrigation, la fertilisation et les fortes charges animales génèrent des risques d'infestation parasitaire très élevés.

Des études sur la variabilité génétique de la résistance de la chèvre Créole à l'infestation naturelle des nématodes gastro-intestinaux sont actuellement menées en station dans deux systèmes de pâturage (Mandonnet *et al.* 1997b). Une variabilité génétique significative a été observée pour des chevreaux âgés de 6 mois élevés en conditions favorables ou non. La corrélation génétique calculée entre résistance et croissance est de +0,50 ($P<0,001$).

Un programme intégré de contrôle du parasitisme interne incluant la conduite des troupeaux et des pâturages, la complémentation ainsi que la résistance génétique est actuellement mis au point.

Parasitisme externe

La chèvre est sensible à la cowdriose (*heartwater*) transmise par les tiques. De nombreux cas de cowdriose caprine apparaissent partout en Guadeloupe et tout au long de l'année. Le cycle épidémiologique de cette maladie est caractérisé par un équilibre instable entre un stock très pathogène de *Cowdria*, une tique peu infestée mais très répandue, et la population caprine locale parmi laquelle existent des lignées résistantes (Camus *et al.* 1996). Le meilleur moyen de lutte contre la cowdriose reste le détiquage régulier (2 fois / mois) des animaux.

Productivité

La conduite semi-intensive des animaux et des pâturages aboutit à des niveaux élevés de productivité rapportée à la chèvre ou à l'unité de surface. La chèvre Créole peut produire 96 kg de chevreaux sevrés durant sa carrière reproductrice de 5 ans, soit 3,4 fois son poids adulte. D'autre part, une moyenne de 1 385 kg chevreaux sevrés / ha / an a été régulièrement obtenue durant les 15 dernières années de notre troupeau expérimental. Devendra & Mc Leroy en 1982 ou Wilson & Light en 1986 n'ont jamais reporté de tels niveaux de productivité.

Figure 5. Chèvre Créole adulte allaitante en Guadeloupe.

Après sevrage, seuls des systèmes herbagers ont été étudiés sur une longue période. Ils autorisent 1 130 kg de gain / ha / an et une moyenne de 1 200 kg de carcasse / ha.

Conclusion

Nous concluons que la chèvre Créole, race tropicale rustique, présente un fort potentiel de production dans des conditions d'élevage adéquates. Ceci représente des possibilités optimistes de développement pour les éleveurs. Par ailleurs un projet d'amélioration génétique de la chèvre Créole est en cours et prendra en compte les caractères de reproduction, les qualités maternelles ainsi que la résistance génétique au parasitisme des animaux.

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Characteristics of Garole sheep in India

R.C. Sharma, A.L. Arora, H.K. Narula & R.N. Singh

Central Sheep and Wool Research Institute, ***Avikanagar****, Rajasthan-304501, India*

Summary

Garole, a highly prolific breed of sheep can be characterised as real microsheep of India. Literature available in respect of its genetic potentiality for fecundity and other economic parameters is very scanty. This has peculiar characteristics such as prolificacy, resistance to foot rot disease, grazing in knee-deep water, adaptability to hot humid conditions and high mothering instinct for their neonates. Some research and development programmes have recently been initiated by Central and State Governments to study this valuable germplasm in a systematic manner. Endeavours are required to evaluate this animal in its home tract and *in-situ* conservation involving local sheep farmers is necessary for posterity.

Resumen

La raza Garole, raza ovina altamente prolífica, puede ser considerada como una auténtica *microsheep* de la India. La literatura disponible sobre el potencial genético de fecundación y otros parámetros económicos es muy escasa. Esta raza posee características particulares tales como la prolificidad, la resistencia contra el pedero, el pastoreo en agua, la adaptabilidad a condiciones de alta temperatura con humedad, así como un importante instinto materno. El Estado central y regional ha iniciado recientemente algunas investigaciones y programas de desarrollo para estudiar este importante germoplasma de forma más sistemática. Se necesitaran mayores esfuerzos para evaluar este animal en su habitat por lo que será necesario llevar a cabo posteriormente una conservación *in situ* con los ganaderos locales.

Key words*: Garole, Sheep, Prolificacy, Characteristics.*

Introduction

The Garole is found in the Sunderban area located in the 24-Parganas district of West Bengal. This animal is of short stature with a light brown coarse texture coat. Multiple birth is a common feature of this breed. Turner (1982) speculated that ancestors of Garole sheep were imported in Australia from Bengal in late 18th century and these sheep might have contributed prolificacy to the Booroola Merino sheep. Many body and fleece characteristics of Garole sheep are similar to those reported for early Bengal sheep in Australia (Piper and Bindon, 1996). Garole ewes exhibit high mothering instinct for their newly born lambs. They tend to stay with their lambs for at least the first 9-10 days in spite of going out to graze. Garole sheep are generally reared by the Haldar community in small flock sizes (5-7 sheep) and are maintained mainly upon grazing on field boundaries, fallow land and on the verges of the road (Ghalsasi and Nimbkar, 1993). Resistance to foot rot disease is a peculiar characteristic of this breed and animals can graze during the rains and even in standing water.

Habitat and Numbers

The habitat of the Bengal breed of sheep locally known as Garole is Sunderbans (Southern part of West Bengal) comprising of 13 blocks of South 24-Parganas and 6 blocks

Figure 1. Garole ram.

of North 24-Parganas district. South 24-Parganas is a coastal part of saline area agriculturally poorly developed due to poor drainage in monsoons coupled with lack of irrigation facilities during the winter and summer seasons. It is situated within 21° to 23° N latitude and 87° to 89° E longitude and spread over approximately 4 226 km^2. The delta is said to be the largest in the World (Bose and Moitra, 1995). It is the low lying region at the Ganga river, the highest elevation being 200 metres above sea level. Part of the region is in Bangladesh and it is expected that such type of animal (Garole) might also be found there. The breeding tract of this breed is tropical humid with an average rainfall of 1 750 mm per annum. Almost in every month there is some rain but its concentration lies between the months of May and October. Maximum precipitation is received during the monsoon and humidity ranges between 60 and 97 per cent. The average maximum and minimum temperatures are 36°C in summer and 13°C in the winter season.

As per livestock censuses of India, the total sheep population has increased more than twofold from 1951 (0.62 million) to 1992 (1.49 million) in West Bengal whereas, in India as a whole, it increased from 3.91 to 5.08 million during this period. The Sunderbans area, where Garole sheep are found, has a sheep population of around 0.16 million as per the survey conducted by Birla Technology Institute and Agricultural Finance Corporation of West Bengal (Singh and Bohra, 1996). However, the population status of this breed and trend of population structure over the passage of time is not exactly known and there is hardly any reference available on these parameters.

Morphological Characteristics

By and large, Garole sheep have a light brownish coat colour. Very few sheep with completely black or white coat colour or black / white spot on the body can also be found. The fleece is open and very coarse.. Usually farmers do not shear their animals and utilise them for meat purpose only. Males are horned and females are polled. The Garole has a compact and square body with a small head, medium ears and a short thin tail. The fleece cover on the coat is not dense but covers almost the whole body and the greater part of the legs. Photographs of the animals of this breed are presented in figure 1 through to 6.

It is a small sized animal with a relatively low body weight in comparison to medium and heavy breeds of sheep. The average adult body weight in males and females being 14.43 and 14.14 kg, respectively. The Udder is fairly well developed and twins can easily be sustained on milk available from the ewe. Some managemental manipulations are required to feed triplets and quadruplets.

Body measurements

A total of 46 adult sheep (14 males and 32 females) belonging to different farmers' flocks were measured. The average body measurements are depicted in table 1. Height at withers and body length were more in males in comparison to contemporary females where the opposite situation was observed in case of heart and paunch (belly) girth. The distance between eye and tail length was also on the higher side in males than in females.

Figure 2. Garole ewe.

The average ear length was 6.75 and 7.36 cm for males and females respectively. On the basis of shape and length, ears of Garole sheep can be further classified into three distinct categories viz. rudimentary (<4 cm) medium, (4-8 cm) and long (>8 cm). The percent of sheep measured having rudimentary, medium and long ears were 13.04, 58.70 and 28.26 respectively. The present results lie in within the range reported by Ghalsasi and Nimbkar (1993) for length, height and heart girth. Similar measurements for adult animals were reported by Bose and Moitra (1995).

Table 1. Body measurements of Garole sheep.

Parameters (cm)	Male	Female
Height at withers	50.71±0.788 (14)	45.34±0.369 (32)
Body length	49.46±0.904 (14)	47.84±0.578 (32)
Heart girth	58.79±0.927 (14)	60.11±0.627 (32)
Paunch /Belly girth	56.50±1.148 (14)	62.65±0.696 (32)
Eyes	9.79±0.255 (14)	8.06±0.092 (32)
Ear	6.75±0.620 (14)	7.36±0.431 (32)
Tail	11.04±0.334 (14)	10.20±0.347 (32)

Within parenthesis are number of observations.

Figure 3. Garole ewe with twins.

Table 2. Production characteristics of Garole sheep.

Traits	Number of observations	Averages (kg)
Birth weight	96	0.82±0.03
3-month weight	34	5.29±0.20
6-month weight	20	7.47±0.31
12-month weight	8	11.54±0.63
Adult body weight		
Male	14	14.43±0.62
Female	31	14.14±0.32
Wool yield	42	0.18±0.02

Reproduction and breeding

Garole, although a highly prolific sheep is not well known to common masses. Literature available with regard to its genetic merit for multiple births is very meagre. These sheep breed all year round in their home tract with no pronounced breeding season, however, maximum lambing takes place between December to February and August to September. The age at first service is 7 to 9 months and age at first lambing is 12 to 14 months. Gestation period is 150 days and lambing interval is 8 months (Bose and Moitra, 1995).

A total of sixty lambings were recorded at the Central Sheep and Wool Research Institute, Avikanagar from May, 1997 to August, 1998. During the said period, the percentage of ewes giving birth to single lambs, twins, triplets and quadruplets were 40, 53.33, 5.0 and 1.67 respectively. The average number of lambs born per ewe was 1.68.

By and large similar observations on multiple births have been reported by Bose and Moitra (1995) and Singh and Bohra (1996), however, Ghalsasi and Nimbkar (1993)

Figure 4. Garole ewe with triplets.

Figure 5. Garole ewe with quadruplets.

reported somewhat higher figures for multiple births than those in the present findings.

Production characteristics

Being a small sized animal, the body weights at different ages and adult weight of Garole sheep are comparatively lower than the medium and heavy breeds of sheep. The observations on production characteristics of Garole sheep were collected at the Institute farm and are summarised in table 2. A small flock of Garole sheep was procured from its home tract in March, 1997 and is being maintained for full study on this valuable germplasm. Farmers, in general, do not shear their animals and are ignorant about the use of wool. The average adult annual wool yield of 42 animals procured from Sunderban area was 179 gms as per the shearing done at the Institute in April, 98. The wool is for rough carpet use. The average fibre diameter, medullation, staple length and crimp/cm were 67.82 µ, 75.17 %, 5.09 cm and 2.08 respectively (Singh and Bohra, 1996).

Research and Development

This breed has been lacking national attention and no genuine and systematic attempts have been made for its improvement, in spite of certain peculiar characteristics viz. prolificacy, knee-deep water grazing habit, resistance to foot rot disease and adaptability to hot humid conditions. Considering the importance of multiple births in sheep breeding, Garole sheep have recently been introduced into the Mutton Project at the Central Sheep and Wool Research Institute, Avikanagar. Efforts are simultaneously being made to ensure that body weights are not adversely affected. A

Figure 6. Flock of Garole sheep.

total of 64 Garole sheep (15 males and 49 females) were procured in March, 1997 from the Sunderbans area with the objective of studying this germplasm thoroughly and introducing prolific genes into relatively less prolific breeds of sheep. In years to come, Garole crossbreds will be evaluated in terms of multiple births and net economic returns. Around 50 animals of this breed are being maintained at KVK, Nimpith and State Livestock Farm, Kalyani for research and development purposes (Singh and Bohra, 1996).

Breeds like Pattanwadi and Sonadi of the North-Western region can be considered for improvement in having multiple births by introducing Garole blood into such breeds of sheep. It is expected that relatively higher milk yield available in these breeds will help the farmers to sustain twin / triplet lambs expectedly born out of Garole x Pattanwadi, Garole x Sonadi or other similar breed combinations.

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Traditional goats and fat-tailed Sabi sheep in semi-arid north eastern Zimbabwe

S.J.G. Hall

*Overseas Development Institute, Portland House, Stag Place, **London** SW1E 5DP, UK*

Summary

Characterisations are given of the little-known Sabi sheep and the local population of the Small East African goat in two areas in NE Zimbabwe. The southern area had been more affected by drought in 1991-92. For sheep (both areas combined; n = 28 in 10 flocks) the mean declared age of breeding females and the median age at first parturition were surprisingly high (6.1 years and 4 years respectively). Breeding female goats in the southern area were younger (4.9 vs. 6.4 years), and their age at first kidding was lower (3 years vs. 5 years), than in the north (n = 122 in 25 flocks total). These advanced ages could be an after-effect of the drought. Juvenile mortality and the proportions of young that were ultimately marketed were similar to what has been found elsewhere in semi-arid Africa. Breeding females were found to be smaller than their counterparts in semi-arid areas in West Africa with mean withers heights of 56.5 cm (n = 112 goats) and 60.4 cm (n = 36 sheep). Conditions in this area appear difficult for small ruminants and the populations sampled may be well adapted to marginal environments and thus worthy of conservation.

Resumé

Il manque encore de l'information sur les petits ruminants du secteur traditionnel de Zimbabwe. Des données zootechniques étaient recueillies sur les moutons Sabi (races à queue grasse) et sur les chèvres de race Small East African (variant de Zimbabwe), sous gestion traditionnelle dans deux aires du nord-est de Zimbabwe. Les tailles des échantillons étaient de 28 brébis en dix troupeaux, et de 122 chèvres, en 25 troupeaux. Les deux aires étaient séparées par 20 - 30 km de broussailles presque dépopulées. Dans les deux aires combinés, les brébis étaient assez âgées (6,1 ans), et l'âge du premier vêlage (4 ans) était bien avancé. Dans l'aire du sud, plus affecté par les sécheresses, les chèvres étaient moins âgées (4,9 cf 6,4 ans au nord) avec un âge au premier vêlage moins avancé (3 cf. 5 ans). Ces âges avancés étaient peut-être une conséquence de la sécheresse. Les taux de mortalité et de commercialisation des jeunes étaient de même ordre que ceux déjà observées en Afrique semi-aride. Les ovins et les caprins sont de moindre taille que leurs équivalents des zones semi-arides d'Afrique occidental (hauteurs au garrot, 56,5 cm; n = 112 chèvres; 60,4 cm; n = 36 brébis).

Key words: *Sabi sheep, Small East African goat, Productivity, Traditional management, Semi-arid Africa.*

Introduction

In the traditional livestock sector in Zimbabwe, goats are better characterised than sheep (Sikosana, 1992, 1996) but field data are lacking on both species. Mason (1988) did not describe any distinct breeds of goat in Zimbabwe, though variants of the Small East African goat were noted. The Sabi sheep, a fat-tailed breed, was briefly described by Ward (1959, 1983). Sikosana (1996) described

Figure 1. Ewes and lambs, Sabi sheep in Rwenya, Zimbabwe.

it as the only indigenous breed of sheep in Zimbabwe, and as being an 'endangered breed in need of conservation'.

In the present study, metrical data were gathered in order to characterise these animals, and an assessment was made of performance in two study areas separated by a corridor, 20-30 km wide, of effectively uninhabited bush.

Methods

The study areas, denoted RS and RN, are located to the south and north respectively of the Rwenya Wildlife Management Area (Hall, 1998). Annual rainfall is highly variable, usually 450 - 600 mm; there can be severe dry spells with a drought in 1991-92 (IIED, 1992; R.M. Blench, in preparation). The holdings of goats and sheep of 31 owners, 28 of whom also owned the cattle described by Hall (1998) were visited, all were within 2 km of a dirt track. Numbers of parous female sheep (ewes) and goats were noted.

Livestock owners were asked about the breeding history of each female, and the fates of all offspring. Reproductive rate was defined as the number of pregnancies per breeding female per year since the start of her breeding career.

Tape measures were used to measure ewes and female goats and notes were made of incisor teeth, coat colour and of presence or absence of horns, and of wattles (fleshy,

Table 1. Dentition (number of adult incisors) of parous female goats.

	Juvenile only	1 pair	2 pairs	3 pairs	4 pairs
Goats RS	1	0	5	8	40
Goats RN	2	2	6	20	38

Table 2. Fates of progeny of goats.

	RS	%	RN	%	chi²
Total live births	160		178		
Died before 6 months	25	15.6	31	17.4	0.16
Died after 6 months	24	15.0	7	3.9	11.19
Kept in herd	84	52.5	110	61.9	1.26
Transferred	27	16.9	30	16.8	0
Totals		100.0		100.0	12.61 $p < 0.01$

Figure 2. Ewes and lambs, Sabi sheep in Rwenya, Zimbabwe.

paired appendages hanging from the throat of some sheep and goats; also called tassels) and beard in the case of goats.

Statistical analysis was mainly by t-tests, Wilcoxon-Mann-Whitney tests (both 2-tailed) and X^2 tests, the latter with d.f. = 1 unless otherwise stated.

Results

Holdings of breeding female goats ranged from two to eleven in both RS (n = 10, mean 5.6±0.99), and in RN (n = 15, mean 4.6±0.70); these did not differ significantly. For sheep, as sample sizes were small, data from areas RS and RN were combined. Holdings of breeding female sheep ranged from two to eight (n = 8, mean 4.5±0.78). Only Sabi sheep were encountered. Case histories were obtained for 28 sheep and for 122 goats (68 in RN and 54 in RS).

Goats

Reproductive histories

The mean declared age of parous females in RS was 4.9±0.29 years and in RN, 6.4±0.24 years, which is highly significantly greater. Median age at first parturition followed the same pattern, being 3 years (range 1 - 7) in RS and 5

Table 3. Mean (SEM) body dimensions (cm) of goats (n = 122) and sheep (n = 36), RS and RN combined.

	goats	sheep
Heart girth	67.1 (0.39)	69.4 (0.84)
Withers height	56.5 (1.35)	60.4 (0.66)

years (range 2-9) in RN ($p < 0.001$). In RS, 13 goats were primiparous (24%) and in RN a nonsignificantly different proportion, 22 (32%) . In RS, 8 primiparae had full adult incisor dentition but in RN, only 5 animals had ($p < 0.05$).

The incisor dentition of the goats is reported in table 1. A significantly lower proportion of the parous goats from RN had full adult dentition (38 out of 68 compared with 40 out of 54 in RS; $p < 0.05$).

The goats in RS had had 99 litters and those in RN, 124, i.e. means of 1.8±0.13 and 1.8±0.15 litters per female respectively (ns). Only two sets of triplets had been born, both in RN. Proportions of multiple births were 36/99 in RS, and a significantly lower proportion, 29/124 ($X^2 = 4.49$, $p < 0.05$) in RN.

Mean litter size did not differ between RS and RN, being 1.25±0.03 for the areas combined.

Fates of offspring

These are considered in table 2. The main difference between the areas was in deaths after 6 months of age. Classifying kids according to litter size, in RS, of the 72 twins born 16 (22.2%) died and of the 86 singles, 9 (10.4%) died ($p<0.05$). In RN, of the 60 twins and triplets born, 12 (20.0%) died and of the 113 singles, 19 (16.8%) died (NS).

Metrical data

There were no differences in body size between the goats of RS and those of RN so the data from all 122 goats were pooled (Table 3).

Figure 3. Sabi ram, Zimbabwe

Figure 4. Sabi ram, Zimbabwe

Qualitative data

In RS, 37 female goats possessed horns, and 23 a beard. In RN, 62 had horns and 21 a beard. One goat in each area had wattles. Beards therefore were equally frequent in RS and RN (ns) while horns were more frequent in RN ($p<0.001$). The most common coat colour was black (24 in each area) while light brown was much more frequent (19 goats) in RN than in RS (one goat only). Other colours observed were white, tan, grey, cream, red-brown and combinations of these.

Sheep

Reproductive histories

The mean age of the 28 parous sheep was 6.1±0.39 years; median age at first parturition was 4 (range 1 - 8) years. Four sheep were primiparous, three of them having 4 pairs of adult incisors. Considering all 28 sheep, 11 had two pairs of adult incisors, 15 had 4 pairs and the other two had one and three pairs respectively.

There had been 70 litters, i.e. 2.5±0.19 litters per female, or 0.87±0.05 litters per year of parity. Six litters were twins, so mean litter size was 1.1±0.03.

Fates of offspring. Of the 75 lambs born, 11 died before the age of 6 months and two afterwards (17.6%); 9 (12.2%) were later transferred and 53 (71.6%) retained in the flock.

Metrical data

These are given in table 3 for both areas combined.

Qualitative data

Twenty four female sheep (67%) had horns and none had wattles. All male sheep had horns. The most common colour pattern was

brown and white (16), followed by black and white (10), brown (9) and black (1) (Figure 1 to 4).

Four adult male sheep were measured: means were heart girth 75.7, withers height 65.0, body length 62.3, ear 11.3 cm. Tail length and the circumference of the tail at the proximal end averaged 39.8 and 27 cm respectively.

Discussion

This study presents a characterisation of two almost undocumented breeds, in an area which appears only marginal for livestock production. No assessment can be made of nation-wide numerical status; the Small East African goat is probably as plentiful within Zimbabwe (Sandford, 1982) as elsewhere (there are 2 million breeding females in Uganda alone: Mbuza, 1995) (Figure 5). Sabi sheep are less well known, but a nationwide survey would be highly desirable. The Rwenya populations of both breeds may perhaps be regarded, because of the rigours of the environment, as locally adapted types.

Sizes of herds of goats and flocks of sheep (mean number of breeding females 5.4 and 4.5 respectively) were towards the lower end of the range reported by Wilson (1988) for other semi-arid areas in Africa where sedentary management is practised. These small group sizes could be due to some combination of environmental rigour, and of a rather low priority being attached to small ruminants. The market prices of adult male goats and sheep were only 5%, and 8% respectively, of that of an ox (Hall, 1998 and unpublished data). In northern Ghana also in 1997, a male goat commanded 9%, and an adult sheep 13%, of the price of an ox (S.J.G. Hall, unpublished).

In Rwenya breeding females were surprisingly old (mean age of goats 5.7, of sheep 6.1 years) and median ages at first parturition (goats 3 or 5 years, sheep 4 years) remarkably high. Females had had very few litters. Elsewhere in Zimbabwe, Sandford (1982) found mean age at first parturition to be 24 months for goats, which he considered "rather high"; in northern Nigeria it was 12.3 months (RIM, 1990, p. 167). Similarly, median age at first lambing of 4 years for sheep is also high. The only pre-existing data for Sabi sheep cannot be compared as they came from fully managed flocks; 15 months (Ward, 1959) and 23 months (Sikosana, 1996). In Nigerian sheep mean age at first lambing is between 12.3 and 19.3 months (RIM, 1990, p. 201).

Sixteen of the 39 primiparous sheep and goats had four pairs of adult incisors, consistent with late onset of breeding. Elsewhere in Africa this adult dentition is achieved at around 3 years in sheep and perhaps earlier in goats (Wilson and Durkin, 1984).

Probably most breeding sheep and goats present in 1997 in RN and RS were born just after the 1991-92 drought and their puberty could have been delayed and lifetime fertility reduced by poor environmental conditions (I'Anson *et al.*, 1991). That access to food may influence puberty in traditional flocks and herds was suggested by RIM (1990, pp. 167-175, 200-208), who found that sheep and goats kept under less strict sedentary husbandry systems, thus having better access to feed, started breeding at a younger age.

The 1991-92 drought had worse effects in RS than in RN, for cattle (Hall, 1998) and for the small ruminants. The lower mean age of goats in RS suggests the loss of a cohort, and the higher proportion of primiparae in RS with four pairs of adult incisors suggests a retardation of puberty of goats that were born soon after the drought.

These sheep and goats clearly inhabit a marginal environment to which they may well have specific adaptations; this could justify conservation efforts as well as making them the appropriate genotypes for any livestock development programme.

Prolificacy and juvenile survival

Prolificacy of the goats, with multiple births accounting for about 25% of litters, is similar to that reported for Small East African goats elsewhere in Zimbabwe (twinning rate

Figure 5. Small East African goats, Zimbabwe

30-32%) by Sikosana (1992), while their mean litter size (1.3) is in the middle of the African range (Wilson and Durkin, 1988). In the present study at 19.3% estimated juvenile mortality rate is less severe than the 30-50% estimated by Sikosana (1992, 1996).

Prolificacy of the sheep, with 9% of litters being multiple births and a mean litter size of 1.08, is similar to that of Sabi sheep in a managed flock (Sikosana, 1996) and also to other African findings (Wilson and Light, 1986). Overall, juvenile mortality of sheep (14.9%) was similar to that reported by Ward (1959) and by Sikosana (1996) for Sabi sheep (i.e. 17.9 and 14% respectively) and is towards the lower end of the range observed elsewhere in semi-arid Africa (range 12.6-30.2%; Wilson *et al*., 1985).

Phenotypic characterisation

This is the first report on the body measurements of the Zimbabwe population of Small East African goats. Compared with nearby populations they are rather smaller than Malawian goats (heart girth 69.4, body length 63.5 cm, body weight 23.9 kg: Ayoade, 1981) and also smaller (withers height 56.5 cm) than those of southern Zimbabwe (withers height 70 cm: Sikosana, 1992).

Mason (1988) states wattles to be 'common' elsewhere in this breed, as does Sikosana (1992), but in the present study only two out of 112 goats had them. On the basis of these quantitative and qualitative differences, the goats described here may be a distinctive variant of the Small East African goat.

The goats of RS and RN differ in the high frequency of the polled characteristic in the former and of the light brown coat colour in the latter, so the two areas could be reproductively isolated, supporting the speculation of Sikosana (1992) that local populations are inbred.

In body length, the goats and sheep measured here are similar to the breeds of northern, semi-arid Nigeria which are respectively 58.1 and 59.7 cm long. However, the Zimbabwe animals are much shorter at the withers (goats 56.5, sheep 60.4 cm, cf. Nigerian goats, 64.3, sheep 72.5 cm: Hall, 1991). The association in West Africa of long-legged sheep and goats with semi-arid regions, and of their short-legged conspecifics with humid zones, is well known (Bouchel and Lauvergne, 1996) so it is perhaps

surprising to find relatively short-legged sheep and goats in semi-arid Zimbabwe. Perhaps the populations are of only recent establishment and these adaptations have not yet become fixed, but this seems unlikely since the Rwenya area has clearly been settled since well before colonial times (R.M. Blench, in preparation). Alternatively, long legs may only be an adaptation to semi-arid conditions under transhumant systems, where ability to trek long distances is important.

Livestock marketing in the Rwenya area mainly concentrates on cattle (Sandford, 1982). Yet sheep and goats are highly likely to have a role in the economic development of the region, provided marketing arrangements can be improved, in which case the local breeds are presumably the appropriate ones to use. Thriving local populations would serve not only for in situ conservation but also as a means to sustainable livestock development.

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Relaciones genéticas entre razas ibéricas de caballos utilizando caracteres morfológicos (prototipos raciales)

J. Jordana y P. M. Parés

Unitat de Genètica i Millora Animal, Departament de Patologia i de Producció Animals, Facultat de Veterinària, Universitat Autònoma de Barcelona, 08193-Bellaterra, ***Barcelona****, España*

Resumen

A partir del estudio cualitativo y cuantitativo de 46 caracteres morfológicos, obtenidos a partir de recopilaciones bibliográficas, se analizan las relaciones existentes entre 17 poblaciones equinas de la Península Ibérica (14 razas españolas y 3 portuguesas).

Los resultados obtenidos permiten clasificar a las diferentes razas en sus correspondientes troncos ancestrales: *Equus ferus gmelini, Equus ferus przewalski* y *Equus ferus solutreensis*, integrándose los representantes de los dos primeros grupos en el llamado Tronco Tarpánico.

El promedio de distancia morfológica entre razas, medida como MCD (Mean Character Difference, o promedio de diferencias entre caracteres), tomó un valor de 0,51± 0,11. El análisis cuantitativo de los datos indica que el grupo que forman los poneys ibéricos es morfológicamente muy semejante, a diferencia de lo que ocurre con los grupos de los caballos de silla y los de tiro.

Se analizan las relaciones y se discuten las causas de la variabilidad morfológica entre grupos.

Summary

Starting from the qualitative and quantitative examination of 46 morphological characters, obtained from bibliographical recompilation, the relationships existing between 17 equine populations of the Iberian Peninsula (14 Spanish and 3 Portuguese breeds), were analysed.

The results obtained allow the different breeds to be classified in their corresponding ancestral trunks: *Equus ferus gmelini, Equus ferus przewalski* and *Equus ferus solutreensis*, integrating the representatives of the first two groups into the so called Tarpanic Trunk.

The average morphological distance between breeds, measured as MCD (Mean Character Difference), had a value of 0.51 ± 0.11. The quantitative analysis of data indicated that the group formed by the Iberian ponies is morphologically very similar, in contrast to that which occurs with the groups of the riding and carriage horses.

The relationships are analysed, and the causes of the morphological variability between groups are discussed.

Key words*: Iberian horse breeds, Morphological characters, Genetic relationships, Dendrogram.*

Introducción

Para estudiar las relaciones genéticas existentes entre diferentes especies, razas o poblaciones, el material más apropiado debería ser el análisis de la variabilidad de genes neutros estructurales, con una elevada tasa de polimorfismo y sin ninguna relación con respecto a la eficacia biológica de los individuos, cuyos alelos hubieran aparecido en la población por mutación y se hubieran mantenido o perdido por deriva. Este

material sería, por ejemplo, los llamados polimorfismos bioquímicos, y más especialmente los marcadores de ADN, minisatélites y microsatélites (Bruford y Wayne, 1993; Bowcock *et al*., 1994).

Existen diferentes estudios llevados a cabo en la especie equina utilizando marcadores genéticos (Bowling y Clark, 1985; Rognoni *et al*., 1996; Behara *et al*., 1998). No obstante, el análisis, mediante métodos de taxonomía numérica (Sneath y Sokal, 1973), de diversos caracteres morfológicos, podría proveer de información adicional que suplementara estas investigaciones, y en algunos casos podría ayudar a contrastar algunas de las hipótesis mantenidas por otros autores, postuladas a partir de diferentes fuentes de información: históricas, arqueológicas, bioquímicas, etc., (Altarriba *et al*., 1979; Lauvergne *et al*., 1988; Jordana *et al*.,1992, 1993).

La importancia de los caracteres morfológicos en la reconstrucción de las relaciones genéticas en razas de caballos, quedó patente en el trabajo llevado a cabo por Jordana *et al.* (1995) en un total de 22 poblaciones equinas mundiales a partir del análisis de 30 caracteres morfológicos, puntualizando, sin embargo, que los resultados obtenidos intentan tan solo mostrar el grado de relación y semblanza morfológica entre razas actuales de caballos, el cual puede ser o no un indicador de la verdadera historia evolutiva de las poblaciones. Debemos considerar que los caracteres morfológicos han estado sujetos, durante un largo período de tiempo, a la selección natural y artificial, así como al hecho de que ha existido migración génica entre alguna de estas poblaciones, siendo por tanto estas fuerzas evolutivas las que habrían tenido un mayor peso en el proceso de diferenciación racial.

El principal objetivo de este artículo es estudiar las relaciones existentes entre todas las razas equinas de la Península Ibérica (España y Portugal), a partir del análisis cualitativo y cuantitativo de datos morfológicos, utilizando métodos estadísticos (SAS, 1989) y programas computacionales diseñados específicamente para tal tipo de análisis (Swofford, 1993).

Material y Métodos

Razas estudiadas

Se analizaron un total de 17 poblaciones equinas Ibéricas. Cinco razas de aptitud silla: Andaluza (AND), Catalana (CAT), Lusitana (LUS), Mallorquina (MAL) y Menorquina (MEN); ocho razas de poneys: Asturcón (AST), Gallego (GAL), Garrano (GAR), Jaca Navarra (JAN), Jaca Soriana (JAS), Losino (LOS), Pottoka (POT) y Sorraia (SOR), y cuatro razas de tiro: Aragonesa (ARA), Bretón Cerdà (BRC), Bretón Empordanès (BRE) y Burguete (BUR). También se incluyó en este estudio la Raza Asnal Catalana (RAC) como población *outgroup*. La localización geográfica se muestra en la figura 1. Algunas razas de caballos se muestran en las figuras de 4 a 12.

Caracteres y análisis

Tomando como referencia un individuo ideal, representativo de cada una de las 17 poblaciones equinas y de la raza asnal catalana, se analizaron un total de 46 caracteres morfológicos. El estado de cada uno de los caracteres, para cada raza, se estableció a partir de datos bibliográficos de diferentes estudios morfológicos de la raza en cuestión; Andaluza (Aparicio *et al.*, 1986), Aragonesa y Bretón Empordanès (Homedes, 1967; Sierra, 1987), Asturcón (García-Dory, 1980), Bretón Cerdà (Torres, *et al*., 1983; Parés y Parés, 1991), Burguete (Gil y Martínez, 1958; Dévimeux, 1988), Catalana (Moyano, 1908), Gallego (Iglesia, 1983; Santamarina, *et al*., 1992), Garrano, Sorraia y Lusitana (Oom, 1992), Jaca Navarra (Donezar, 1951), Jaca Soriana y Losino (Ferreras, 1935a), Mallorquina (Payeras y Pons, 1991), Menorquina (Sánchez-Belda, 1987), Pottoka (Ferreras, 1935b; Maguregi *et al*., 1992) y la Raza Asnal Catalana (Jordana y Folch, 1996).

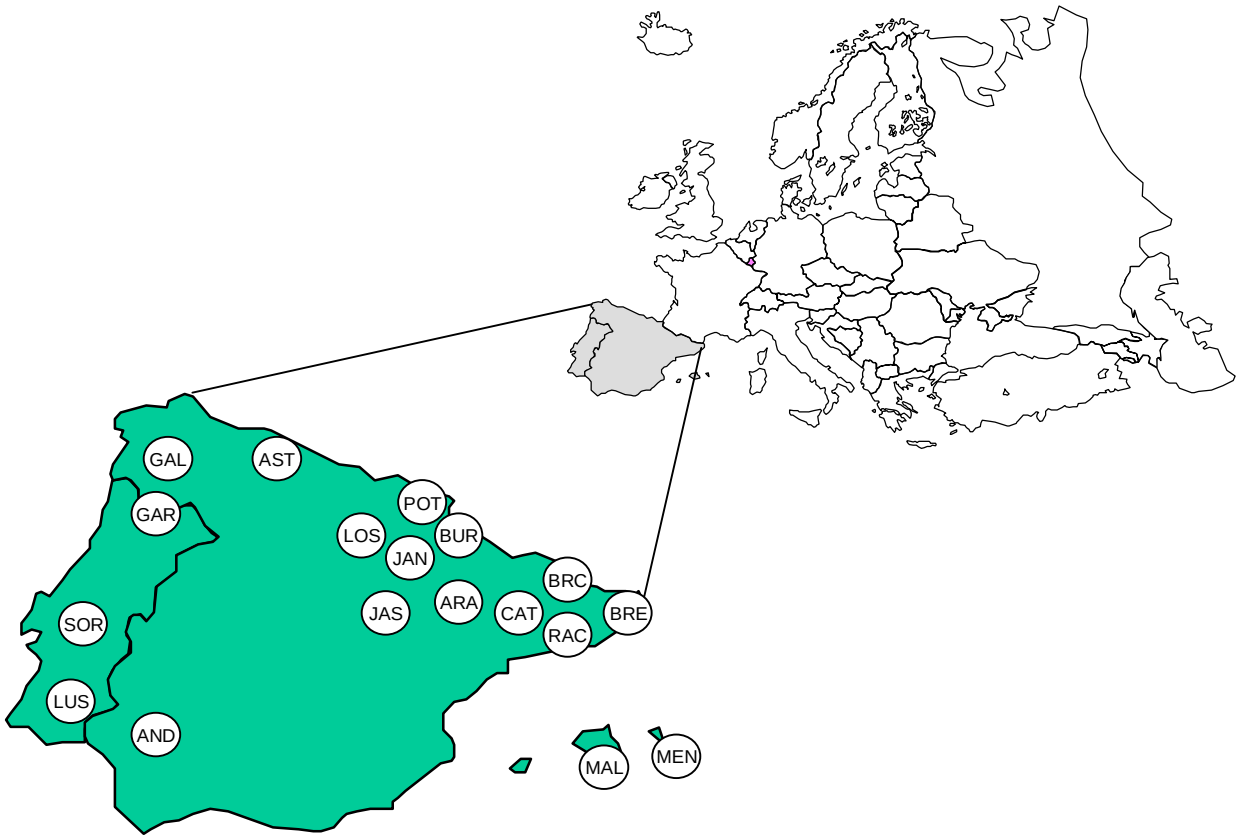


Figura 1. Principal localización geográfica de las razas equinas ibéricas.

Para cada estado de los diferentes caracteres se asignó un orden numérico de forma arbitraria. Estos números no representan ninguna ponderación específica. El número de estados para cada carácter se estableció dependiendo del número de clases fenotípicamente distinguibles. Los caracteres utilizados y el estado de los mismos se muestran en la tabla 1. La matriz original de semejanzas morfológicas se muestra en la tabla 2.

El programa PAUP (Swofford, 1993) se utilizó para realizar el análisis cualitativo de los datos a partir de los caracteres discretos mostrados en la tabla 2. Este análisis se basa en el principio de la parsimonia, es decir, el árbol generado (dendrograma) sería aquel que requiriera el menor número posible de pasos o transiciones del estado del carácter, sumados a través de todas las ramas. El método utilizado fue el de la parsimonia de Fitch (Fitch, 1971). Para darle una dirección evolutiva, los árboles resultantes fueron rotados utilizando el método del *outgroup* (Farris, 1972) con la Raza Asnal Catalana. El programa PAUP nos permite, asimismo, calcular la confianza que nos merece la topología, mediante un análisis *bootstrap* (Efron, 1979) adaptado a la inferencia de filogenias (Felsenstein, 1985). Se realizaron cien replicaciones *bootstrap*, y el árbol de consenso se obtuvo basándonos en el método *majority-rule* (Margush and McMorris, 1981) producido por el algoritmo *global-branch-swapping* (Hendy and Penny, 1982). Para el análisis cuantitativo, los datos cualitativos fueron transformados y procesados en forma de una matriz de distancias. Se calculó el promedio de diferencias entre caracteres o distancia MCD (Mean Character Difference) propuesta por Cain y Harrison (1958), la cual varía de 0 a 1, y se utilizó como una medida de parecido taxonómico. Los cálculos se llevaron a cabo utilizando el paquete estadístico SAS (1989).

Tabla 1. Caracteres y estados de los mismos, utilizados en la construcción de la matriz de semejanzas morfológicas.

(A) Perfil cefálico 0. Subcóncavo 1. Rectilíneo 2. Subconvexo 3. Rectilíneo o Subconvexo 4. Convexo	*(B) Tamaño corporal* 0. Elipométrico 1. Eumétrico 2. Subhipermétrico 3. Hipermétrico
(C) Proporción long/anchura 0. Brevilíneo 1. Mesolíneo 2. Sublongilíneo 3. Longilíneo	*(D) Alzada a la cruz* 0. < 140 cm. 1. 141 - 148 cm. 2. 149 - 154 cm. 3. 155 - 160 cm. 4. 161 - 170 cm.
(E) Perímetro torácico 0. < 160 cm. 1. 161 - 170 cm. 2. 171 - 185 cm. 3. 186 - 190 cm.	*(F) Peso vivo en machos* 0. < 200 Kg 1. 200 - 450 Kg 2. 450 - 500 Kg 3. 500 - 650 Kg 4. 650 – 1 000 Kg
(G) Proporción cabeza/cuerpo 0. Pequeña 1. Proporcionada 2. Grande	*(H) Anchura de la cabeza* 0. Estrecha 1. Media 2. Ancha
(I) Tamaño de la frente 0. Reducida 1. Mediana 2. Grande	*(J) Perfil frontal* 0. Cóncavo 1. Recto 2. Subconvexo 3. Subcóncavo 4. Convexo
(K) Longitud de la cara 0. Acortada 1. Mediana 2. Alargada	*(L) Perfil de la cara hasta la parte inferior de los supranasales* 0. Cóncavo 1. Recto 2. Convexo
(M) Perfil de la cara desde la parte inferior de los supranasales 0. Cóncavo 1. Recto 2. Convexo	*(N) Tamaño de las orejas en relación a la cabeza* 0. Largas 1. Medianas 2. Pequeñas
(O) Orbitas 0. Salientes 1. De prominencia media 2. No salientes	*(P) Apófisis cigomáticas* 0. Poco manifiestas 1. Bien manifiestas

(To be continued...)

(...To be continued)

(Q) Supranasales
0. Estrechos
1. Anchos

(R) Ollares
0. Pequeños
1. Grandes

(S) Labios
0. Finos
1. Gruesos

(T) Perfil del cuello
0. Ligeramente arqueado
1. Arqueado
2. Recto
3. Hundido

(U) Forma del cuello
0. Piramidal
1. Masivo
2. Cervuno

(V) Longitud del cuello
0. Corto
1. Medio
2. Largo

(W) Anchura del cuello
0. Delgado y estrecho
1. Medio
2. Ancho

(X) Cruz
0. Poco prominente
1. Manifiesta

(Y) Longitud de la espalda
0. Corta
1. Media
2. Larga

(Z) Costillar
0. Plano
1. Con suave arqueamiento
2. Cilíndrico

(A) Conformación del pecho
0. Medio
1. Ancho
2. Muy ancho

(B) Profundidad del pecho
0. Poco profundo
1. Intermedio
2. Profundo

(C) Longitud del dorso
0. Reducida
1. Mediana
2. Alargada

(D) Línea dorsal
0. Ligeramente ensillada
1. Recta

(E) Longitud del lomo
0. Reducida
1. Larga

(F) Línea del lomo
0. Ligeramente ensillada
1. Recta

(G) Grupa
0. Horizontal
1. Ligeramente inclinada
2. Inclinada
3. Inclinada y doble
4. Muy inclinada

(H) Nacimiento de la cola
0. Bajo
1. Medio
2. Alto

(I) Extremidades
0. Finas y delgadas
1. Fuertes y robustas

(J) Cascos
0. Pequeños y altos
1. Medianos
2. Grandes y anchos

(To be continued...)

(...To be continued)

(K) Color de la capa 0. Ratonera 1. Negra 2. Torda 3. Castaña 4. Alazana y castaña 5. Negra y castaña 6. Torda y castaña	*(L) Marcas blancas* 0. Ausentes 1. Presentes o no en la cabeza, pero siempre de forma muy discreta. 2. Presentes en cabeza y extremidades. 3. Presentes o no en la cabeza y extremidades, pero siempre de forma muy discreta.
(M) Raya de mulo 0. Ausente 1. Presente	*(N) Banda crucial* 0. Ausente 1. Presente
(O) Cebraduras 0. Ausentes 1. Presentes	*(P) Piel* 0. Fina 1. Gruesa
(Q) Crines 0. Cola y crin cortas 1. Cola y crin largas y escasas cernejas 2. Cola y crin largas y abundantes cernejas	*(R) Crin* 0. Enhiesta y corta 1. Caída
(S) Aptitud fisiológico-mecánica 0. Poney 1. Silla 2. Tiro ligero 3. Tiro pesado 4. Vive en estado salvaje	*(T) Biotipología constitucional* 0. Hipermetabólico u oxidativo 1. Metabólico u ortosténico 2. Muscular o masivo.

Resultados y Discusión

Análisis cualitativo

El dendrograma resultante de la aplicación del método de la parsimonia de Fitch a los caracteres morfológicos (tabla 2) se muestra en la figura 2. La raza asnal Catalana se utilizó como población *outgroup*. Para la construcción del dendrograma el método de la parsimonia de Fitch necesitó 215 pasos o transiciones (longitud total del árbol) para reordenar los caracteres y obtener el árbol de máxima parsimonia. El índice de consistencia (una medida de la homoplasia) fue de 0,456. Las distancias de rama y de internodos son proporcionales al número de cambios requeridos en el estado del carácter.

Los caballos domésticos actuales podrían ser descendientes de tres tipos fundamentales: el *Equus ferus gmelini*, el *Equus ferus przewalski*, y el *Equus ferus stenonis, robustus o solutreensis.* No obstante, Sotillo y Serrano (1985) y Groves (1986) postulan que el caballo de Przewalski (*Equus przewalski*) podría ser la variante sud-oriental del Tarpan

Tabla 2. Matriz de semejanzas morfológicas.

C/R[a]	RAC[b]	AND	ARA	AST	BRE	BRC	BUR	CAT	GAL	GAR	JAN	JAS	LOS	LUS	MAL	MEN	POT	SOR
A	0	2	4	1	0	2	1	1	1	1	1	1	1	2	2	3	1	2
B	2	1	2	0	3	2	2	1	0	0	0	0	0	1	1	1	0	0
C	3	0	1	1	0	1	1	3	1	1	1	1	1	1	2	1	0	1
D	1	3	3	0	4	2	1	2	0	0	0	0	0	3	2	4	0	0
E	0	2	4	0	4	3	2	1	0	0	0	0	0	2	2	2	1	0
F	1	2	4	1	4	3	3	1	1	0	0	0	1	3	2	2	1	0
G	2	1	2	1	2	1	2	2	2	2	2	0	0	1	2	2	1	0
H	2	0	2	0	1	1	2	0	0	0	1	1	0	1	2	1	0	0
I	2	2	2	2	2	2	2	0	2	2	2	1	2	0	2	1	2	2
J	1	4	2	3	1	1	1	1	2	1	1	1	1	4	2	1	0	4
K	2	2	2	2	2	2	0	1	2	2	2	2	2	2	2	2	2	2
L	1	2	2	2	1	1	1	1	2	2	2	2	2	2	1	1	2	2
M	1	2	2	1	0	1	1	2	1	1	1	1	1	2	2	1	1	1
N	0	1	0	2	0	2	2	2	2	2	2	2	2	1	2	1	2	2
O	0	0	2	1	1	0	1	0	1	0	0	0	0	0	0	1	0	1
P	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q	1	0	0	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1
R	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1
S	0	1	0	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1
T	2	1	1	3	2	1	0	2	3	2	3	2	2	0	2	0	3	3
U	0	1	1	2	1	1	1	1	0	2	2	2	2	0	0	1	2	2
V	2	1	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	1
W	2	1	0	0	2	2	1	0	0	1	0	1	1	1	1	2	0	0
X	0	1	1	1	0	0	0	1	1	0	0	1	1	1	1	0	1	1
Y	2	2	0	0	0	1	1	2	2	2	2	2	0	2	2	2	2	2
Z	1	1	2	1	2	2	1	1	0	1	1	1	1	1	1	1	1	0

(To be continued...)

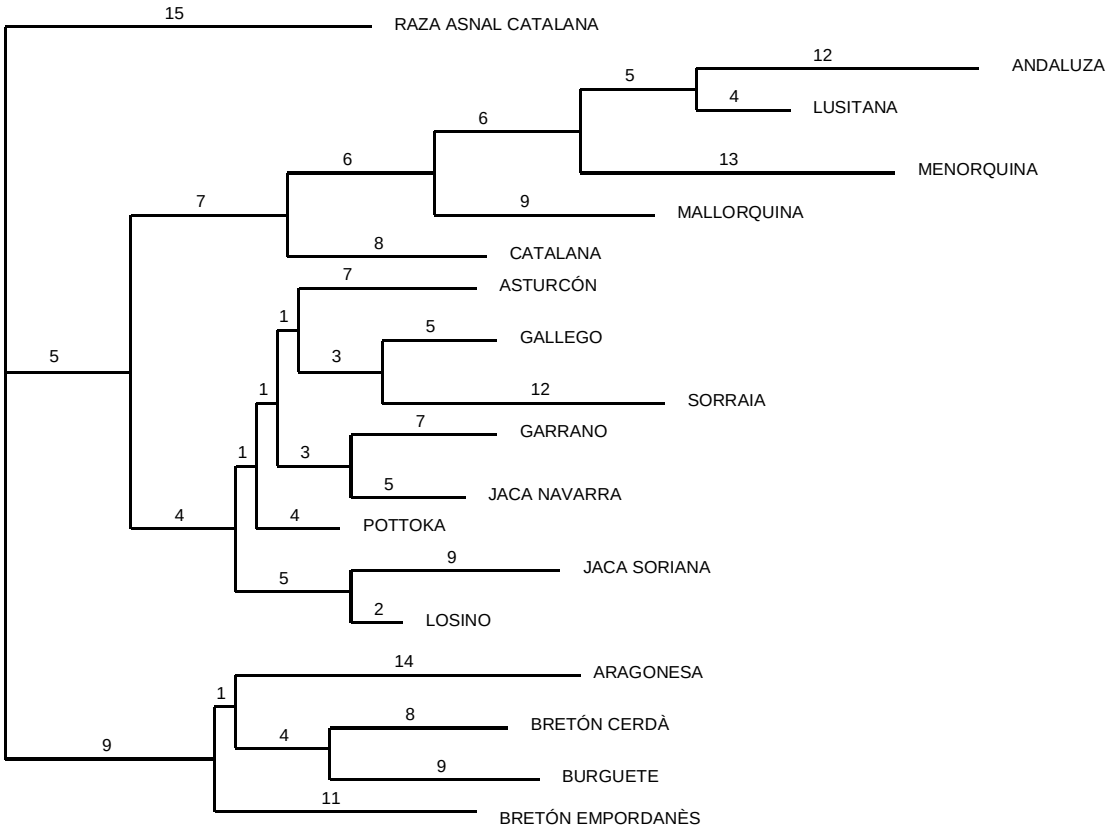
(...To be continued)

C/R[a]	RAC[b]	AND	ARA	AST	BRE	BRC	BUR	CAT	GAL	GAR	JAN	JAS	LOS	LUS	MAL	MEN	POT	SOR
A	1	1	1	1	2	2	1	0	1	1	1	1	1	0	1	0	1	0
B	1	2	2	1	2	2	2	1	0	1	1	2	1	1	1	0	1	0
C	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
D	1	0	1	0	1	1	0	1	0	1	1	1	0	1	0	1	1	1
E	1	0	0	1	0	0	0	1	1	0	1	0	0	0	1	1	0	0
F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
G	0	2	2	2	3	2	3	1	2	0	4	2	2	1	2	1	2	1
H	0	0	0	0	0	1	1	2	0	1	0	1	0	0	0	0	0	0
I	1	0	1	0	1	1	1	1	0	0	0	0	1	1	0	1	1	0
J	0	1	2	0	2	2	2	1	0	0	0	0	0	1	2	1	0	1
K	1	2	2	1	5	4	3	5	5	3	3	6	5	6	1	1	5	0
L	2	2	0	0	3	2	0	3	2	2	0	1	1	3	0	3	0	2
M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
P	0	1	0	1	1	1	1	1	1	1	0	0	0	1	1	0	1	1
Q	0	2	2	1	2	2	2	1	0	1	1	2	1	1	1	2	1	1
R	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S	2	1	3	0	3	3	3	2	0	4	0	0	0	1	1	1	0	0
T	0	1	2	1	2	2	2	1	1	1	2	1	1	1	1	1	1	1

[a] C / R = Caracteres / Razas

[b] Ver texto para los códigos

Figura 2. Análisis cualitativo de los datos morfológicos (Tabla 2). Dendrograma producido mediante el análisis PAUP, resultante de la aplicación del método de la parsimonia de Fitch. Las distancias de rama e internodos son proporcionales al número de cambios requeridos en el estado del carácter. El árbol fue rotado utilizando la raza asnal Catalana como población outgroup.



(*Equus gmelini*), y que habría sido introducido en Africa y Europa a través de Egipto y el Estrecho de Gibraltar (España), integrándose todos sus descendientes en el llamado Tronco Tarpánico. Los resultados obtenidos en el estudio de las razas equinas de la Península Ibérica y los obtenidos por Jordana *et al.* (1995) en un total de 22 razas equinas mundiales, en las que se incluía el Tarpan y el Przewalski, confirmarían esta hipótesis.

En este árbol podemos observar dos grandes grupos perfectamente definidos. Uno de ellos formado por trece razas: Andaluza, Lusitana, Menorquina, Mallorquina, Catalana, Asturcón, Gallego, Sorraia, Garrano, Jaca Navarra, Pottoka, Jaca Soriana y Losino (grupo A), que se corresponderían con los descendientes del Tronco Tarpánico. El otro gran grupo, que se corresponde con los descendientes del Tronco Solutrensis, incluye cuatro razas: Aragonesa, Bretón Cerdà, Burguete y Bretón Empordanès (grupo B).

En el Tronco Tarpánico es posible, a su vez, diferenciar dos subgrupos: el A1, que se corresponde con los poneys ligeros, es decir, Asturcón, Gallego, Sorraia, Garrano, Jaca Navarra, Pottoka, Jaca Soriana y Losino, descendientes directos del *Equus gmelini*. Las otras cinco razas, Andaluza, Lusitana,

Figura 3. Arbol de consenso y porcentaje de replicaciones bootstrap obtenido a partir de los datos morfológicos utilizando el programa PAUP.

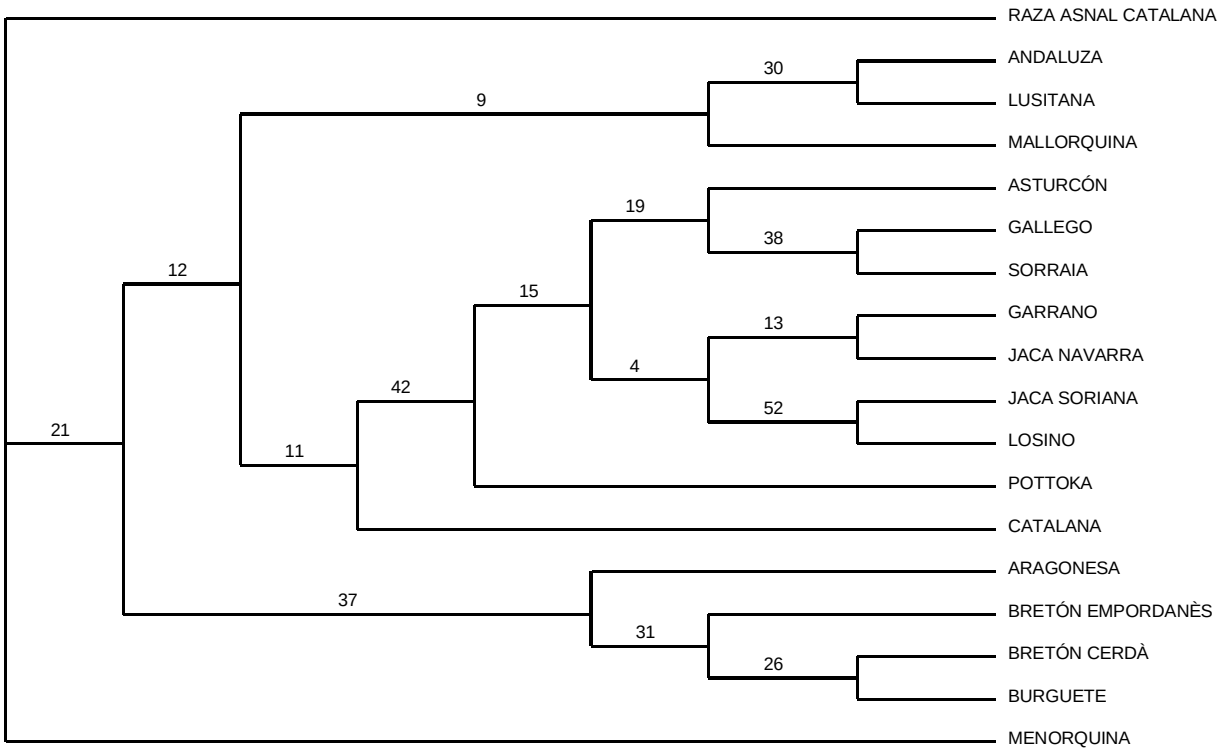


Figura 4. Caballo de raza Andaluza.

Figura 5. Caballo Breton.

Menorquina, Mallorquina y Catalana formarían el subgrupo A2, y se corresponderían con los representantes del *Equus przewalski.*

La figura 3 representa el árbol de consenso obtenido después de cien replicaciones *bootstrap*; los valores en el árbol indican el porcentaje de replicaciones obtenidas después del análisis, es decir, la amplitud del intervalo de confianza. Ambos dendrogramas, el más parsimonioso y el de consenso son muy similares, manteniéndose los tres grupos anteriormente descritos, con la excepción de la raza Menorquina, que forma una tricotomía no resuelta con la raza asnal Catalana y las demás razas equinas. No obstante, los bajos niveles de significación indicarían que existe poca confianza con esta ordenación.

Es sorprendente que los niveles de significación del análisis *bootstrap* obtenidos en este estudio sean substancialmente menores que los obtenidos por Jordana *et al.* (1995). En los dos trabajos las diferentes razas se adscriben perfectamente en sus respectivos troncos ancestrales, confirmándose la estrecha relación existente entre los individuos de los troncos *Equus gmelini* y *Equus przewalski*, conformando el Tronco Tarpánico y confirmando la hipótesis de Sotillo y Serrano (1985) y Groves (1986); sin embargo, el nivel de confianza es substancialmente diferente. Creemos que esto puede ser debido, principalmente, a que el área geográfica de las 17 poblaciones analizadas en este estudio es muy restringida (España y Portugal), y por tanto, las posibilidades de migraciones génicas entre razas habrían sido mayores, en comparación con las otras razas de distribución mundial más amplia. Esto podría comportar una mayor homogeneidad en los caracteres morfológicos analizados, con lo cual la ordenación de las diferentes razas en sus respectivos troncos ancestrales tendría un menor nivel de confianza, indicándonos

Tabla 3. Matriz de distancias morfológicas (MCD) entre las razas equinas ibéricas.

Razas	AND	ARA	AST	BRE	BRC	BUR	CAT	GAL	GAR	JAN	JAS	LOS	LUS	MAL	MEN	POT	SOR
Andaluza (AND)	****																
Aragonesa (ARA)	0.50	****															
Asturcón (AST)	0.50	0.63	****														
Bretón Empordà (BRE)	0.61	0.48	0.63	****													
Bretón Cerdà (BRC)	0.54	0.50	0.61	0.37	****												
Burguete (BUR)	0.59	0.52	0.54	0.43	0.33	****											
Catalana (CAT)	0.57	0.67	0.57	0.59	0.59	0.59	****										
Galllego (GAL)	0.52	0.61	0.22	0.63	0.59	0.54	0.52	****									
Garrano (GAR)	0.54	0.70	0.37	0.61	0.50	0.46	0.50	0.37	****								
Jaca Navarra (JAN)	0.63	0.59	0.28	0.59	0.52	0.48	0.52	0.33	0.24	****							
Jaca Soriana (JAS)	0.52	0.61	0.39	0.61	0.52	0.54	0.61	0.43	0.30	0.33	****						
Losino (LOS)	0.54	0.57	0.26	0.61	0.57	0.52	0.50	0.33	0.30	0.33	0.24	****					
Lusitana (LUS)	0.33	0.59	0.59	0.67	0.57	0.61	0.41	0.61	0.54	0.57	0.57	0.54	****				
Mallorquina (MAL)	0.41	0.59	0.48	0.65	0.61	0.54	0.46	0.46	0.52	0.52	0.61	0.52	0.46	****			
Menorquina (MEN)	0.52	0.63	0.65	0.52	0.61	0.59	0.52	0.65	0.67	0.59	0.57	0.65	0.43	0.57	****		
Pottoka (POT)	0.48	0.59	0.22	0.59	0.52	0.54	0.41	0.28	0.33	0.28	0.39	0.24	0.48	0.50	0.70	****	
Sorraia (SOR)	0.54	0.74	0.37	0.67	0.63	0.70	0.61	0.35	0.39	0.43	0.46	0.48	0.54	0.63	0.65	0.41	****

Figura 6. Caballo de raza Gallega.

asimismo, que razas de diferentes troncos habrían podido intervenir en la formación y mejora de otras.

Análisis cuantitativo

Los valores de la distancia MCD entre las razas ibéricas de caballos se muestran en la tabla 3. El promedio de distancia entre razas toma un valor de 0,51 ± 0,12, con valores extremos de 0,22 entre los pares Asturcón-Gallego y Asturcón-Pottoka, y de 0,74 para el par Aragonesa-Sorraia.

Este valor medio de MCD entre las razas ibéricas fue ligeramente inferior al obtenido por Jordana *et al.* (1995) con 22 razas equinas mundiales (MCD = 0,57 ± 0,17), aunque las diferencias no fueron estadísticamente significativas (F = 2,12; no significativa).

Cuando se analiza la variabilidad morfológica intragrupo, mediante el cálculo de los correspondientes MCDs, se obtienen los siguientes valores promedio para cada uno de los grupos: MCD = 0,33 ± 0,07 para el grupo A1 *(Equus gmelini*), MCD = 0,47 ± 0,08 para el grupo A2 (*Equus przewalski*), y MCD = 0,44 ± 0,08 para el grupo B (*Equus solutreensis*). El test de la F para contrastar la heterogeneidad de las medias mediante el método de Student-Newman-Keuls (SAS, 1989), indicó que únicamente existen diferencias significantes entre el grupo A1 y los otros dos, A2 y B ($F = 14,24$; $P < 0.001$). Este resultado indicaría que las razas descendientes de *Equus gmelini* (poneys ligeros) tendrían una mayor relación de semblanza morfológica que los representantes de los otros troncos ancestrales, corroborando la estrecha relación observada en el dendrograma de la figura 2 (bajos valores de distancia de rama e internodo, los cuales son proporcionales al número de cambios requeridos en el estado del carácter). El relativamente elevado valor (42%) del análisis *bootstrap* (Figure 3), cuando es comparado con los otros valores, también confirmaría este elevado nivel de semejanza morfológica.

Figura 7. Caballo de raza Jaca Navarra.

Los ligeros poneys ibéricos, que se localizan mayoritariamente en las regiones septentrionales de España y Portugal, y cuyos orígenes se remontan a los antiguos poneys celtas traídos a la Península Ibérica durante las sucesivas invasiones (Dévimeux, 1988; Santamarina *et al.*, 1992) habrían sufrido pocas introgresiones génicas de razas foráneas durante su formación y posterior evolución y mejora, lo cual redundaría en un mayor grado de parecido morfológico. En cambio, en las razas que conforman los grupos de los caballos de silla (grupo A2) y los de tiro (grupo B), la aportación génica de otras razas foráneas habría sido manifiesta, hipótesis apoyada por las informaciones históricas que se tienen al respecto, con lo que los valores MCD intragrupo serían superiores y estadísticamente significativos cuando se comparan con el grupo de los poneys.

Así, por ejemplo, en la formación y posterior evolución del caballo Andaluz, habrían influido sobre las primitivas poblaciones de caballos ibéricos, razas tales como el Berberisco y el Arabe, así como poblaciones de caballos númidas y germánicos (Aparicio, 1960; Bongianni, 1987). En las otras razas ibéricas de silla, también habrían influido, principalmente, las razas Berberisca y Arabe, aunque en cada caso particular ha podido haber influencia de otras razas equinas mundiales, como, por ejemplo, en la raza Mallorquina, donde la influencia de caballos de la Italia Central y Meridional (raza Napolitana y caballos negros de la Corte Vaticana) ha sido importante (Dévimeux, 1988).

También en las razas de tiro (grupo B), la aportación genética foránea ha sido muy importante. Basta citar la referencia que sobre ellas hacen Sotillo y Serrano (1985), cuando señalan que España no poseía caballos de tiro hasta prácticamente el siglo pasado, en el que, sobre la base de yeguas de silla del norte de España actuaron, principalmente, razas pesadas francesas. Las principales influencias sobre el Bretón Empordanès y el Bretón Cerdà han sido debidas al Bretón Postier francés, aunque la población de Bretón Cerdà también ha recibido un cierto aporte genético de razas

Figura 8. Caballo de raza Menorquina.

Figura 9. Caballo Pottoka.

Figura 10. Caballo de raza Mallorquina.

tales como el Ardenés, Boloñés y Percherón (Parés y Vilaró, 1994). El caballo de Burguete se originó a partir del cruce entre sementales Bretón Postier y yeguas locales próximas a la Jaca Navarra y al Pottoka. En cuanto a la raza Aragonesa, el mayor aporte genético provino de la raza francesa Percherón, aunque otras razas tales como el Ardenés, Boloñés, Normando y Bretón también contribuyeron en su mejora (Sotillo and Serrano, 1985; Sierra, 1987). Por último, sólo comentar que en muchas de las razas europeas de tiro, y también en las españolas (*Equus solutreensis*), las razas Arabe y Andaluza (*Equus przewalski*), principalmente, han contribuido de forma notable en su mejora (Hartley, 1981; Baudoin, 1991), con lo que, lógicamente, la variabilidad morfológica intragrupo (medida como MCD) se vería aumentada.

Asimismo, la intensidad de selección (selección artificial) llevada a cabo sobre diferentes caracteres de interés (morfológicos, funcionales, etc.,) también habría sido substancialmente diferente para los tres grupos, siendo casi nula para el grupo de los poneys (grupo A1) y de una importancia relativa para los representantes de las razas de silla y tiro (grupos A2 y B, respectivamente). Elevadas intensidades de selección para diferentes caracteres en las diferentes razas, podrían contribuir al incremento del grado de variabilidad morfológica entre las razas dentro del grupo (grupos A1 y B), y a reducir dicho nivel de variabilidad (mayor parecido morfológico) cuando las diferentes poblaciones (grupo de los poneys, A2) no se ven afectadas por la selección artificial de los caracteres en estudio.

Conclusiones

Como principales conclusiones de este estudio podemos señalar la confirmación, al menos desde el punto de vista morfológico, de la hipótesis propuesta por Sotillo y Serrano (1985) y Groves (1986), de que el caballo de Przewalski (*Equus przewalski*) podría ser la variante sud-oriental del Tarpán (*Equus*

Figura 11. Caballo Burguete.

gmelini), integrándose todos sus descendientes en el llamado Tronco Tarpánico, conclusión también expresada por Jordana *et al.* (1995); no obstante, debería ser verificada a través del análisis de marcadores moleculares. Asimismo, se comprueba que el grupo que forman los poneys ibéricos es morfológicamente muy semejante, a diferencia de lo que ocurre con las razas de silla y las de tiro, posiblemente debido a un mayor aislamiento genético, a una casi nula selección artificial para los caracteres morfológicos, y a una elevada movilidad de reproductores intra-grupo, conclusión que también tendría que ser contrastada a través del análisis de marcadores genéticos.

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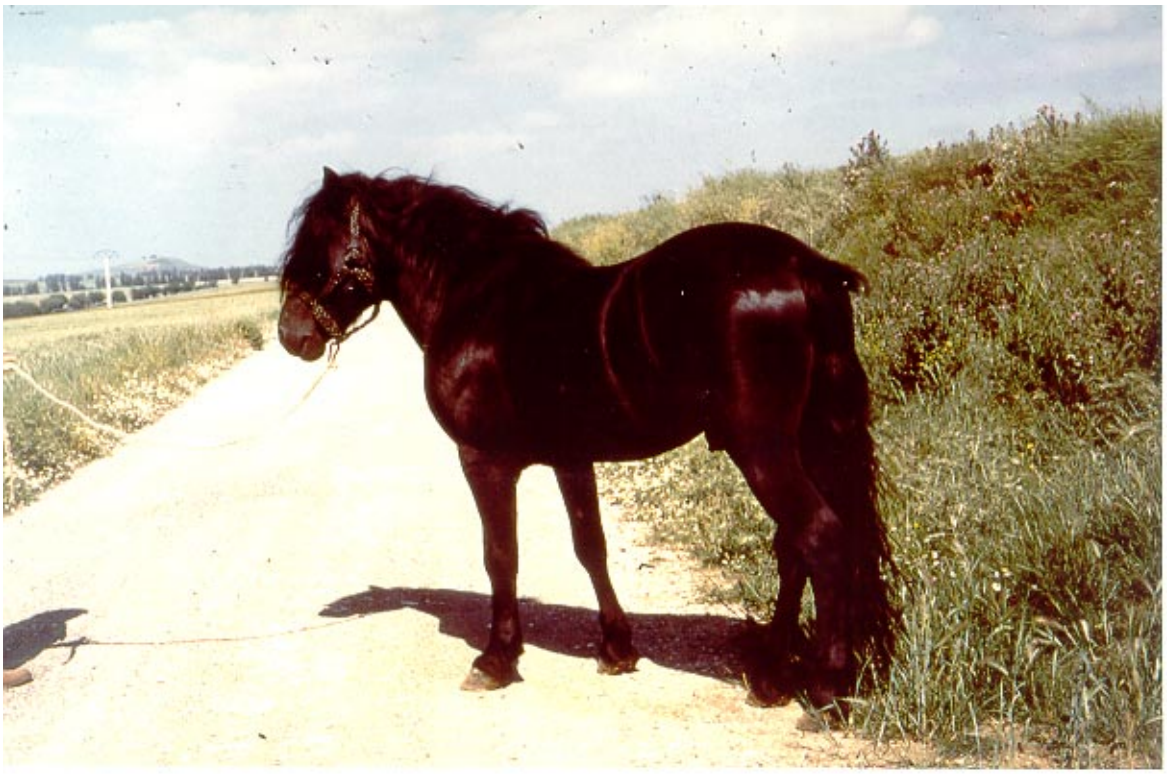

Figura 12. Caballo Losino.

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Rabbit genetic resources of Egypt

M.H. Khalil[1, 2]

[1]*Department of Animal Production & Breeding, Faculty of Agriculture and Veterinary Medicine, King Saud University,* ***Buriedah****, Qassim, P.O. Box 1482, Kingdom of Saudi Arabia*
[2] *On Secondment from Department of Animal Production, Faculty of Agriculture at Moshtohor, Zagazig University,* ***Moshtohor****, Qalyoubia, Egypt*

Summary

In Egypt, there are three breeds of rabbits, Giza White, Baladi and Gabali. For Baladi rabbits, there are three strains; Baladi Red, Baladi White and Baladi Black, while Sinai Gabali and Desert Gabali are considered the two strains of Gabali rabbits. Giza White rabbits are usually called improved Giza or El-Giza El-Mohassan. These Egyptian rabbits are medium-sized breeds and used mainly for meat production. Giza White and Baladi rabbits are docile, while Gabali rabbits are moderately tractable. Origin, physical description, and census data for these Egyptian genetic resources were described. Also, they were characterized with regard to their performance (e.g. reproductive efficiency, lactational and maternal abilities, growth rate, feed conversion ratio, carcass traits and meat composition, hair and fur quality, etc.) and adaptability to heat stress.

Resumen

En Egipto existen tres razas de conejos, Giza White, Baladi y Gabali. Dentro de la raza Baladi tenemos tres grupos: Baladi Red, Baladi White y Baladi Black; mientras que la Sinai Gabali y la Desert Gabali vienen consideradas como dos grupos de la raza Gabali. La raza Giza White viene llamada normalmente Giza mejorada o El-Giza El-Mohassan. Estos conejos son de un tamaño medio y vienen utilizados principalmente para carne. Las razas Giza White y Baladi son dóciles, mientras que la raza Gabali lo es mucho menos. Se presenta el origen, la descripción física y el censo de este recurso genético animal en Egipto. También se presentan sus características de rendimiento (eficacia de reproducción, capacidad de lactación y materna, índice de crecimiento, índice de conversión, elementos de la canal y composición de la carne, calidad del pelo y de la piel, etc.), así como la resistencia al estrés producido por el calor.

Key Words: *Rabbits, Genetic resources, Characterization, Production performance, Egypt.*

Introduction

The annual consumption of rabbit meat per head of the Egyptian population is low (about 0.7 kg) in comparison with other types of meat and with other Mediterranean countries. The annual per capita consumption of rabbit meat is 3.6, 3.5, 3.5 kg in France, Italy and Spain, respectively. These figures indicate that there is a potential for developing a home market in Egypt.

Most of the Egyptian rabbit genetic resources are endangered since the total number of breeding rabbits is less than 1 500, most of them scattered in state farms. Several attempts have been carried out to edit the information available on rabbit genetic resources, especially in the Mediterranean and European countries. Among these attempts, is the data bank entry developed by the European Rabbit Project funded by the EC in France at the National Instiute for Agricultural Research (INRA) in cooperation

with the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM). The Descriptive Model proposed by Khalil (1993) and the one suggested by Bolet *et al* (1996) were the main forms to introduce data collected into the Data Bank Entry Project. Also, a booklet was published by CIHEAM introducing a descriptive model for rabbit genetic resources in Mediterranean countries with an application to the Egyptian breeds (Khalil, 1997). This booklet was distributed among members of the Mediterranean Rabbit Group (organized by CIHEAM) in order to compile all the information obtained in a book on rabbit genetic resources in Mediterranean countries. Egyptian genetic resources are included in these attempts. Therefore, the objective of this article is to present the information available on the Egyptian breeds of rabbits to be compiled.

Origin of Giza White

In 1932, a native stock of rabbits (Baladi rabbits) was bred by the Animal Breeding Department, Cairo University, Giza, Egypt, in an attempt to form a breed of uniform characteristics (El-Khishin *et al*, 1951). These rabbits were of different colours and sizes. Colours were isolated and black and albino colours were segregated. In 1937, systematic breeding took place with the objective of obtaining an albino type of rabbit with faster rate of growth and a larger litter size which is presently known as the Giza White breed. Closed breeding in the albino population was performed for several years.

Origin of Baladi

Crossbreeding for several generations was practised between local (native='*baladi*' in Arabic) rabbits and the Flemish Giant (G) in stations of the Poultry Breeding Section, Ministry of Agriculture (Badawy,1975; Galal and Khalil, 1994). The breeding plan used for producing the three native strains of Baladi Red (R), Baladi White (W) and Baladi Black (B) is reported in table 1.

Heavier does of the Giant Baladi genotype were upgraded by mating them to pure Giant Flander bucks for several generations and selection for pure colours of red, white and black was practised for producing strains of Red Baladi, White Baladi and Black Baladi.

Table 1. The breeding plan used for producing the three native strains of Baladi Red (R), Baladi White (W) and Baladi Black (B)

Baladi x Baladi Selecting does with heavy weight and of particular colour			
	Red-coloured Baladi (R)	White-coloured Baladi (W)	Black-coloured Baladi (B)
Parents	GXR	GXW	GXB
F1	GR	GW	GB
Backcrossing	G X GR	G X GW	G X GB
Backcross	GR	GW	GB

Does of each strain were mated with bucks of the same strain for several generations until characters and colour were established.

Origin of Gabali Rabbits

This is a medium-sized breed. There are two strains of rabbits in Egypt bearing the name 'Gabali', but they unlikely to be the same. One of these strains is found in the western desert on the north Mediterranean coast and the other in Sinai. The two strains seem to be adapted to the desert conditions. The colour of rabbits is mainly grey. For the western coast rabbits, the Desert Research Center, Ministry of Agriculture, Egypt started a project in Mariout (North Western coast of Egypt) in 1992, to characterise this strain of Gabali rabbits. Another project funded by the Ministry of Agriculture, Egypt started in 1994 in the Faculty of Agriculture at Moshtohor,

Table 2. Herd sizes of Giza White and Baladi rabbits in Governmental and small-scale farms.

Item	Giza White		Baladi	
	Governmental farms	Small-scale herds	Governmental farms	Small-scale herds
Mean:				
Adult animals	40	5	30	3
Young animals	200	30	120	15
Range:				
Adult animals	20-80	2-10	20-50	1-6
Young animals	100-500	20-250	50-200	15-150

Source: Khalil, 1997.

Figure 1. Baladi Red (Female).

Zagazig University, Egypt to characterise Sinai Gabali rabbits genetically as well as to evaluate their crosses with the New Zealand White breed.

Census Data and Herd Sizes

About 500 animals of Giza White and 1 000 animals of Baladi rabbits are the remaining rabbits of these two Egyptian breeds. Census data for Gabali rabbits in Egypt is not available. The approximate size of the herds is shown in table 2. Full details concerning census data were presented by Khalil (1997).

Physical Description of Breeds/Strains

Giza White rabbits are albino with a soft silky fur. They have well-rounded hips, a well-filled loin and ribs that carry forward to combine with shoulders that balance with the rest of the body. The shoulders blend smoothly into midsection, and the midsection smoothly extends into the hindquarters. The body is of medium length with good depth as shown in table 3. The top body line rises in a gradual curve from the base of the ears to the centre of the hips and then fall in a smooth curve downward to the base of the tail. The sides taper slightly from hindquarters towards shoulders. The back is markedly convex without animals being pot-bellied. The skin is smooth. Giza White rabbits have a convex head and pink eyes. They have erect ears, a straight tail and feet and legs of medium length.

For Baladi rabbits, there are three strains named Baladi Red (Figures 1 to 3), Baladi White and Baladi Black (Figures 4 to 6). The three strains of Baladi rabbit have well-rounded hips with a well-filled loin. The ribs are carried forward to combine with shoulders that balance with the rest of the body. The shoulders blend smoothly into the midsection, which smoothly extends into the hindquarters. The body is of medium length with a good depth as shown in table 3. The top body line rises in a gradual curve from the base of the ears to the centre of the hips and then falls in a smooth curve downward to the base of the tail. The sides taper slightly from the hindquarters towards the shoulders. The back is markedly ventrally convex without being pot-bellied. The skin is smooth. All three strains have a convex head, black eyes and erect ears. Feet and legs are medium in length, while tails are straight and relatively short.

Sexual Maturity

Results given in table 4 show that Giza White rabbits are late in their sexual maturity compared to standard breeds (Khalil *et al*, 1989). On the other hand, Gabali rabbits reach their sexual maturity at an early age (about

Table 3. Averages of body measurements (cm) in Giza White and Baladi rabbits at 12 weeks of age.

Item	Giza White	Baladi Red	Baladi White	Baladi Black
Body length	25.0±0.14	23±0.18	21.6±0.13	28.3±0.16
Chest circumference	11.5±0.09	22±0.22	16.4±0.17	21.7±0.21
Loin width	4.6±0.03	4.6±0.03	4.0±0.03	4.6±0.04
Loin length			13.9±0.10	
Thigh circumference	9.0±0.18			11.1±0.25
Ear length		8.5±0.18	8.1±0.25	8.4±0.22

Source: Dora, 1979; Khalil, 1997.

Table 4. Averages of age and weight of doe and buck at sexual maturity in Giza White, Baladi and Gabali rabbits.

Item	Giza White	Baladi Red	Baladi White	Baladi Black	Siani Gabali
Age of buck at 1st mating (month)	7.5±0.6	7.2 ±0.5	6.5±0.4	7.0±0.5	6.2±0.6
Age of doe at 1st mating (month)	7.8±0.5	7.5±0.4	6.8±0.4	7.4±0.5	6.8±0.4
Age of doe at 1st kindling (month)	9.5±0.8	8.5±0.8	7.7±1.2	8.6±0.9	
Weight of buck at 1st service (g)	2 810±40	2850 ±38	2 250±80	2 830±56	
Weight of doe at 1st mating (g)	2 910±66	2 970±42	2 300±80	2 850±68	3 200±87

Source: Dora, 1979; Tag El-Din, 1979& 1992; Khalil and Soliman, 1989; Khalil *et al*, 1989.

Figure 2. Baladi Red (Male).

6.5 months). Differences among Baladi strains in age of buck and doe at first service are small (Table 4) since the three strains mature at about 7 months of age (Soliman, 1983). On the other hand, Baladi White rabbits recorded the least adult weight (2 250 g), while Gabali rabbits recorded the highest adult weight (3 200 g). Baladi Red and Baladi Black are nearly similar in their adult weights (2 850 g).

Lifetime Production per Doe

With full potentiality, the lifetime production of the Giza White doe could be extended for four years. Therefore, Giza White rabbits have a long lifetime production compared to other breeds raised in Egypt (Afifi and Emara, 1986). Doe longevity of this breed ranges from 4.2 to 6.5 years with an average of 4.5 years. The number of litters per doe per annum ranges from 2.2 to 4.2 with an average of 2.8.

Baladi strains of rabbits could be used for breeding for about 5 years. Therefore, they are characterised by long lifetime productions compared to exotic breeds raised in Egypt (Afifi and Emara, 1986). Although this period is relatively long, the productivity of doe per annum is low. This low productivity is shown in Baladi rabbits where the number of litters per doe per annum ranges from 2.1 to 3.5.

Semen Characteristics

Wide variation among Baladi strains in semen characteristics was observed (Table 5; Soliman, 1983). Semen of Baladi Red bucks recorded the highest ejaculate volume and sperm concentration as well as the least dead and abnormalsperm.

Fertility, Fecundity and Prenatal Mortality

The conception rate of Giza White rabbits is relatively higher than that recorded for standard breeds raised in Egypt (Afifi and Emara, 1986). The estimate ranges from 65 to

Figure 3. Baladi Red (Bunnies).

Table 5. Averages of semen characteristics of 8-month bucks in Baladi strains of rabbits.

Trait	Baladi Red	Baladi White	Baladi Black
Reaction time (seconds)	21.0±1.52	18.0±1.52	22±0.98
Ejaculate volume (ml)	0.49±0.04	0.5± 0.04	0.38±0.52
Sperm concentration per ml $(X10)^6$	383.0±8.36	360± 9.39	282± 6.50
Sperm abnormalities (%)	17.7±0.32	27±0.43	30.5±0.64
Dead sperm (%)	11.3± 0.32	20.3±0.38	22.6±0.40

Source: Soliman, 1988.

Table 6. Averages for fecundity traits in Giza White and Baladi rabbits.

Item	Giza White	Baladi Red	Baladi White	Baladi Black	Siani Gabali
Conception rate (%)		75.0±6.2	72±4.7	53.4±5.8	
Kindling interval (days)	48.0	66.6	58	55.0	61
Ovulation rate per litter	8.7±0.56				
Litter size:					
at birth (total born)	6.7±0.11	6.0 ± 0.40	5.3±0.52	5.5 ±0.48	5.91±0.81
at 21 days	6.0±0.12	4.8±0.38	4.4±0.45	4.4 ±0.42	6.0±0.80
at weaning (4 weeks)	5.8±0.12	4.8±0.38	4.5±0.45	4.2±0.40	4.0±0.89
at weaning (5 weeks)	4.5±0.11	4.6±0.39	4.5±0.48	3.8±0.40	3.9±0.92
Litter weight (g):					
at birth	330±5.8	322±21	320±8.3	258±22	360±50.2
at 21 days	1 380±38	1 040±68	960±32	990±42	
at weaning (4 weeks)	1 700±42	1 550±120	1 145±66.1	1 320±48	
at weaning (5 weeks)	1 950±51	1 780±151	1 675±184	1 520±120	2 260±524

Source: El-Fouly,1977; Khalil, 1980; Soliman,1988; Khalil, 1999.

80% with an average of 76%. The kindling interval ranged from 42 to 65 days with an average of 49 days (Khalil, 1993 & 1997).

Giza White rabbits are characterised by a high ovulation rate (El-Fouly *et al*, 1977) and moderate litter size and weight both at birth and weaning (Afifi, 1971, Afifi and Emara, 1987). Litter weight and average weight of young at weaning for Giza White are heavier than those for the three strains of Baladi rabbits (Emara, 1982). Giza White rabbits have moderate embryonic mortality (about 12%

with range of 5-16%) along with moderate stillbirths (about 5.2% with range of 3.5-8.5%). Both embryonic mortality and stillbirths in Giza White rabbits are relatively lower than for Baladi strains (El-Fouly *et al*, 1977). However, averages for litter traits in Giza White at different ages reviewed from literature (e.g. Mostageer *et al*., 1970; Khalil, 1980; Khalil *et al*., 1987a; Afifi and Khalil, 1989; Afifi *et al*., 1989) indicate that the performance of Giza is acceptable as a meat-producing breed (Table 6).

Baladi strains of rabbits have medium to high conception rates ranging from 42% to 85%, while they have relatively long kindling intervals (Table 6). Also, the conception rate of Baladi strains is relatively lower than that recorded for Giza White rabbits (Afifi and Emara, 1986). Results given in table 6 indicate that the size and weight of Baladi White litters are slightly smaller and heavier than litters of Baladi Red and Baladi Black rabbits (Emara, 1982; Hassan, 1988; Soliman, 1988; Khalil *et al*., 1988; Hilmy, 1991).

Prenatal mortality in Baladi rabbits is high compared to other standard breeds. The estimates range from 5 to 14% (El-Fouly *et al*, 1977). However, both prenatal mortality (%) and stillbirths are very similar in the three strains of Baladi rabbits. Also, stillbirths of Baladi rabbits are similar to Gabali rabbits (Galal and Khalil, 1994; Khalil, 1996). The ranges were 3-12%, 4.5-15% and 3-13% young for Baladi Red, Baladi White and Baladi Black, respectively.

Maternal and Lactation Behaviour

Reviewed means and ranges characterising lactating ability of Giza White and Baladi rabbits are presented in table 7 where data indicate a great variability in lactation performance of the Egyptian breeds of rabbits.

The milking ability of Giza White does is low compared to exotic breeds raised in Egypt (Ibrahim, 1985; Khalil, 1994). Although the Giza White breed is more adapted to the Egyptian conditions, the low post-natal maternal ability in such a breed (due to lower milking and suckling abilities) may be the main limiting factor for the full use of such genetic potential on a large scale of

Table 7. Means and ranges characterising lactating ability of Giza White and Baladi rabbits.

Breed	Trait	Mean	Range
Giza White	Number of teats	8.0±0.15	7-10
	21-days milk yield (g)	2640±68	1 890-3 260
	Peak of lactation (in days)	18.5±0.6	16-23
	Peak of lactation (in g)	2 380±35.5	1 570-2 860
	Total milk yield (g)	3 750±97	2 650-4 280
	Fat (%)	19.5±0.4	17-23
	Protein (%)	15.7±0.1	12-18
	Lactose (%)	2.0±0.01	1.8-2.9
Baladi Red	21-days milk yield (g)	2 150±38	1 670-2 380
	Total milk yield (g)	3 200±55	2 480-4 180
Baladi Black	21-days milk yield (g)	2 180±42	1 650-2 480
	Total milk yield (g)	3 550±68	2 450-4 200
Gabali	21-days milk yield (g)	2 235±331	
	Total milk yield (g)	3 383±497	

Source: Ibrahim, 1985; Khalil, 1994, 1996 & 1999.

Figure 4. Baladi Black (Female).

commercial production. Peak lactation in this breed (2 380 g) was reached at 18 days after kindling. Milk components for Giza White rabbits are richer than those in standard breeds raised in Egypt (Ibrahim, 1985). The number of teats in this breed (average 8) is similar to that found in other breeds.

Baladi strains of rabbits (Baladi Red and Baladi Black) as well as Gabali rabbits are low in their lactating abilities to suckle their young, which may be a reason for these rabbits producing low litter size and weight at weaning, together with high mortality rates (Galal and Khalil, 1994; Khalil, 1996). Means and ranges given in table 7 indicate that the milk yield curve for Baladi rabbits is similar to that for Gabali. But, both breeds are very low in their milking ability compared with exotic breeds raised in Egypt. In this respect, total milk yield is about 3 300g in Baladi rabbits and 3 383 g in Gabali relative to 7 200 g for New Zealand White raised in Egypt.

Body Weights and Gains (g) and Food Utilization

Preweaning daily feed intake per litter (0-5 weeks) for Giza rabbits is 195 g with a range of 160-225 g (Abdella *et al*, 1990). Accordingly, daily crude protein and starch per litter per doe during preweaning period were 32 and 120 g, respectively. In comparison with exotic breeds raised in Egypt, results given in table 8 indicate that post-weaning Giza White rabbits have:

1) moderate weights and gains in postweaning growth period (Afifi *et al*, 1990).
2) moderate daily feed intake of about 80 g during fattening period (Afifi *et al*, 1990).
3) low rate of feed conversion (5.2 g feed per gram gain).

Preweaning daily feed intake per litter (0-5 weeks) for Baladi Red and Baladi Black rabbits are about 230 and 240 g, respectively

Figure 5. Baladi Black (Male).

(Radwan *et al*., 1978). It ranged from 160-255 g for Baladi Red and from 170 to 270 g for Baladi White rabbits.

Postweaning body weights and daily gains in Baladi rabbits are lower than those for native Giza White and for other exotic breeds raised in Egypt (e.g. New Zealand, Californian, Chinchilla, Bouscat,. etc..) as cited by Khalil (1980), Afifi and Emara (1990), Tag El-Din *et al* (1992), Youssef (1992) and Afifi *et al* (1993) (Table 8). Contrary to Giza White, figures illustrated in this Table point out that feed intakes by Baladi rabbits are low (about 70 g during fattening period). On the other hand, feed conversion of 5.2 g feed intake per gram gain for Baladi Red is similar to that for Giza White (Boulos, 1978), while Baladi White had a higher conversion rate (about 4.2 feed intake per gram gain).

Carcass Traits and Meat Composition

According to criteria and terminology cited by Blasco *et al* (1992), figures given in table 9 indicate that Giza White and Gabali rabbits are characterised by:

- early age at slaughter (12 weeks) compared to Baladi strains;
- low weight of carcass compared to standard breeds raised in Egypt (El-Sayaad *et al*, 1990).
- light weight of fur;
- moderate content of moisture along with high content of protein in meat (El-Sayaad *et al*, 1990);

For Baladi rabbits, means given in table 9 indicate that the carcasses of Baladi Red and Black rabbits are characterised by:

- late age at slaughter (about 15 weeks for Baladi Red and Black and 18 weeks for Baladi White);

Table 8. Averages for postweaning growth traits and rates of feed intake and conversion per young characterising Giza White and Baladi rabbits.

Trait	Giza White	Baladi Red	Baladi White	Baladi Black	Gabali
Body weight (g)					
4 weeks (weaning)	355±4.8	318	312±5.7		587±56
5 weeks (weaning)	408±8.0	450±6.5	370±10.7		
6- week	560±10.2	530±8.2	460±14.5	512±12	796±62
8- week	790±13.9	785±10.8	595±21.0	744±16	1084±83
10- week	1 150±228	1 035±11.6	710±27.6	1 153±22	1 405±95
12- week	1 350±30	1 310±219	815±36	1 505±24	1 812±87
Daily gain (g)					
5-8 weeks	16.0±1.10	15.0±0.5	13.5±1.2	17.0.±1.2	24±2.1
8-12 weeks	18.0±1.26	13.0±0.4	12.6±1.6	15.0±0.8	22±2.4
12-16 weeks	13.0±0.89	12.7±0.4	9.2±1.4	13.0±0.6	21±2.6
Daily feed intake (g)					
5-6 weeks	54±0.15	54±0.16			
6-7 weeks	68±0.18	68±0.18			
7-8 weeks	80±0.22	73±0.24			
8-9 weeks	88±0.28	86±0.35			
9-10 weeks	98±0.35	90±0.38			
Feed conversion[+]					
5-16 weeks	5.2±0.13	5.2±0.18	4.1±0.24	5.2±0.16	4.2±0.24
30-60 days		4.8±0.14	3.4±0.09		
30-90 days		5.2±0.18	4.6±0.10		

[+]Gram intake per gram gain.
Source: Dora, 1979; Khalil, 1980; Afifi *et al*, 1990; Galal and Khalil, 1994; Khalil, 1997 & 1999.

- moderate weight of hot carcass along with moderate weight of giblets, loin and head;
- moderate dressing percentage as well as low lean percentage and moderate meat:bone ratio;
- heavy weight of fur;
- moderate contents of moisture in meat together with high protein content.

However, carcass performance of Baladi strains is lower than that of standard breeds raised in Egypt (e.g. New Zealand White, Californian, etc...).

Hair and Fur Traits

Averages for hair traits of adult Giza rabbits are presented in table 10. Giza White rabbits are a normal-haired breed with a hair length of 30-40 mm. Giza rabbits have a dense fur. Down-hairs of Giza are longer than those for standard breeds (e.g. Bouscat and Flemish Giant) raised in Egypt, while guard-hairs have an intermediate value (Ibrahim, 1988). Both down- and guard-hairs on hip and side

Table 9. Carcass traits and meat composition characterising performance of Giza White and Baladi rabbits.

Item	Giza White	Baladi Red	Baladi White	Baladi Black	Gabali
Carcass traits					
Slaughter age (weeks)	12	14	18	16	12
Pre-slaughter weight(g)	1 406±32	2 085±24	1 450±32	1 885±76	1 700±42
Hot carcass weight (g)*	650±26	1063±17	670±18	965±38	820±28
Dressing percentage	47.0	51	47	52	48.2
Giblets weight (g)	78±2.8	83±2.2	55±0.66	90±6.2	
Fur weight (g)	107±20.9	155±5.4	135±8.2	250±12.6	125±6.2
Abdominal fat (%)	5.2				
Loin weight (g)	192±26	138±18	90±6.2	140±17.8	95±8.4
Meat: bone (%)		78:22			
Lean percentage		65	64	78	
Head weight (g)	77±3.7	97±2.9	78±1.8	87±2.4	
Meat composition (%)					
Moisture	74	74.8	76.6	69.5	74
Protein	19	19.3	18.2	21.6	19
Ether extracts	2.4	2.1	3.4	6.4	2.6
Ash	1.4	1.2	1.6	3.4	1.2

*Carcass without head.

Source: Dora, 1979; Youssef, 1992 Afifi *et al*, 1990 & 1994; Khalil, 1996 & 1997.

Table 10. Hair traits characterising fur of adult Giza White and Baladi rabbits.

Item	Giza White	Baladi Red	Baladi White	Baladi Black
Hair density (per mm^2)	4 990	3 350	3 625	3 560
Length of down-hairs (mm)	22±0.11	24±0.12	23±0.14	23±0.14
Length of guard-hairs (mm)	33±0.12	38±0.28	36±0.28	36±0.28
Diameter of down-hairs (micron)	16±0.22	20±0.21	20±0.21	20±0.21
Diameter of guard-hairs (micron)	93±0.25	95±0.26	94±0.26	93±0.25
Hair medullation (%)	43±0.58	48±0.84	48±0.86	48±0.82

Source: Ibrahim, 1988.

Figure 6. Baladi Black (Bunnies).

regions have intermediate diameters while hairs on the back region are thin in diameter. Fibres have thinner medulla than the Baladi strains, while they are similar to those in standard breeds (e.g. Bouscat and Flemish Giant).

Baladi rabbits are normal-haired strains (35-40 mm in length). Length of down-and guard- hairs of the three strains of Baladi are longer than those hairs of standard breeds (e.g. Bouscat and Flemish Giant) raised in Egypt (Ibrahim, 1988). Diameter of down- and guard-hairs of Baladi strains are thicker than those of standard breeds. Hairs of Baladi strains have high percentages of medullation contributing to their light - density fur.

Physiological reaction to heat stress

Gabali rabbits are less stressed to heat in comparison with the other Egyptian breeds (Giza White and Baladi). In summer, physiological reaction parameters to heat stress are reasonable, 31°C for hair temperature, 142 for rate of respiration and 18-34°C for ear-lobe temperature (Khalil, 1996).

Under an average annual air temperature of 23.5°C, Giza White rabbits showed average values of 39.4°, 38.4°, 39.1°, 31.1° and 28.2°C for temperature of body, skin, abdomen, hair and ear-lobe (Shafie *et al*, 1970). The average respiration rate and pulse rate per minute were 169 and 235, respectively. New Zealand White rabbits gave similar average body temperatures at the same environmental air temperature. Physiological parameters reported by Kamar *et al* (1975), Hassanein (1980) and Toson (1983) for Giza white rabbits also indicated that this breed is less stressed to heat in summer compared to New Zealand White rabbits.

Different colours of black, red and white for Baladi strains showed highly significant differences in physiological reactions in terms of skin, ear-lobe and hair temperatures as well

as in respiration and pulse rates (Shafie *et al*, 1970). Under an annual average temperature of 23.5°C, Baladi strains are characterised by high responses to climatic stress. With regard to adaptation to heat stress, data obtained by Shafie *et al* (1970) and Toson (1983) show that in Baladi strains, the White rabbits are the most adapted and the Baladi Black rabbits the least.

Genetic Parameters and Selection

Details on estimation of genetic and phenotypic parameters in Giza White and Baladi rabbits were presented in an article by Khalil *et al* (1986). Estimates of repeatability for litter traits, milk yield and reproductive intervals in Giza White rabbits were low, ranging from 0.02 to 0.189. Because of low repeatability for doe traits in this breed, selecting does for these traits based on a single production record would not be efficient from a genetic standpoint (Khalil, 1994). Heritabilities characterising genetic potential of economic traits in Giza White rabbits can be summarised as follows:

1) Estimates for litter traits are low, ranging from 0.05 to 0.27 (Khalil *et al*, 1987a; Khalil *et al*, 1989; Khalil, 1994).
2) Estimates for lactation traits (Khalil, 1993 & 1994), carcass traits (Darwish *et al*, 1970) and hair and fur traits (Ibrahim, 1980) are moderate or slightly high, about 0.18 for lactation traits, while they range from 0.20 to 0.29 for carcass traits and from 0.28 to 0.45 for hair traits.
3) Estimates for heat stress traits (Toson, 1983) and postweaning growth (Khalil *et al*, 1987b; Khalil and Khalil, 1991) are moderate or high, ranging from 0.28 to 0.45 for body temperature, 0.20 to 0.45 for respiration rate and 0.28 to 0.65 for postweaning body weights.

Repeatability for litter traits in Baladi strains of rabbits was low ranging from 0.11 to 0.18 (Khalil *et al*., 1988). Estimates of heritability for litter traits in Baladi strains were higher than those for exotic breeds, i.e. additive genetic variability for litter traits in Baladi rabbits is higher than that in standard breeds. This is because the Baladi strains were not subjected to any intensive selection. These moderate estimates of heritability in Baladi strains are an incentive for Egyptian rabbit breeders to improve doe traits through selection.

Acknowledgement

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ICAR Technical Series no. 2. Cattle Identification and Milk Recording in Central and Eastern European Countries

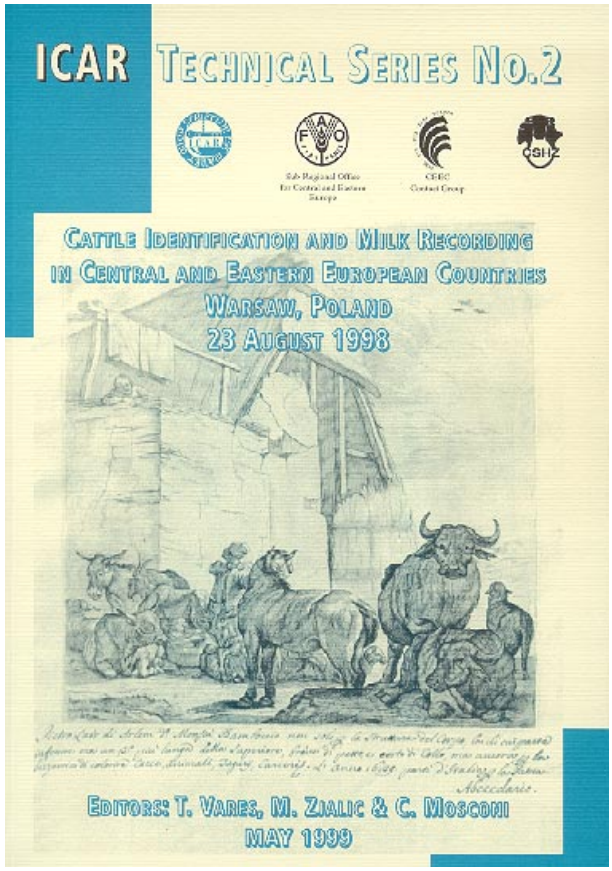
Editors: T. Vares, M. Zjalic & C. Mosconi
Proceedings of an International Workshop held in Warsaw, Poland on 23 August, 1998, jointly organised by ICAR, FAO, EAAP and CHSZ.
ICAR, Villa del Ragno, Via Nomentana 134, 00162 Rome, Italy
Tel.:+39-06-86329141; fax: +39-06-86329263;
e-mail: zoorec@rmnet.it
pp. 135

In all countries of Central and Eastern Europe there are well organised and functional milk recording services. From the organisational point of view, the major part of them is established as independent entities operating under the license issued by the Ministry of Agriculture. They apply ICAR (International Committee for Animal recording) guidelines and control methods in accordance with the local conditions, farm size and costs of operations.

An overview of the current status of milk recording, cattle identification and ICAR membership status in Central and Eastern Europe are presented in this publication, following the workshop held in Warsaw in August 1998. The workshop was attended by 35 experts and a total of 18 papers, including a majority of case study, were presented.

The full proceedings (135 pages) of this most informative workshop were published in May 1999 in this second publication of the ICAR Technical Series.

The Workshop was a joint venture by ICAR, FAO (Sub-Regional Office for Central and Eastern Europe and the Animal Production Division), EAAP (European Association for Animal Production) and CHSZ (Central Animal Breeding Office, Poland).



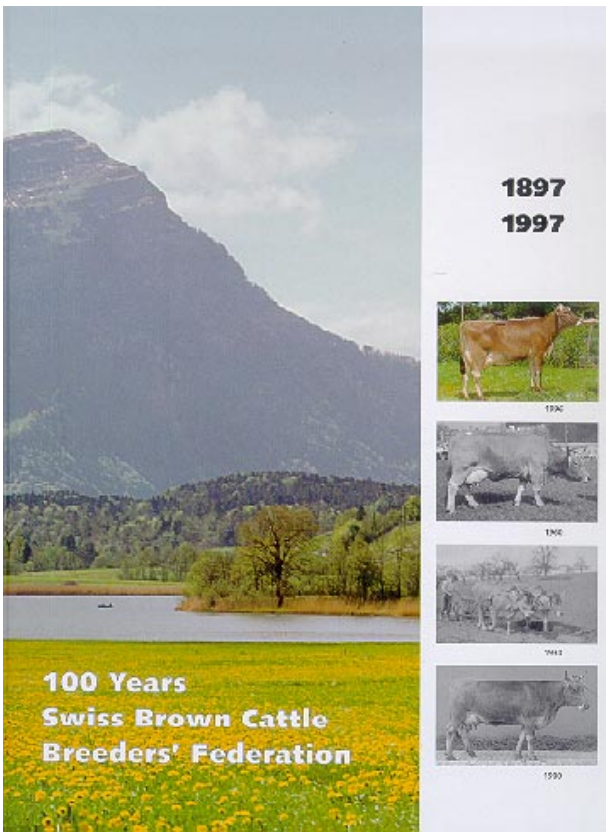
100 years Swiss Brown Cattle Breeders' Federation

Editors: M. Harder & O. Grüter
Production: Kündig Druck AG, 6304 Zug, 1997
pp. 145

The 100 year old history of the Swiss Brown Cattle Breeders' Federation, summarised in this publication, reflects the impact of events around the farmers families, as well as the impact of society and nature surrounding animal breeders. The particular geography of Switzerland with its mountainous and alpine regions as well as lovely meadows and pastures has decisively influenced animal breeding. Influenced by the relatively rich touristic land of Switzerland and by the narrow valleys of many breeders, peculiar and original thoughts developed on the method of how Brown Cattle breeding should be carried out. The reader can find almost any kind of breeder from the traditional, the persistent, the leisurely progressive up to the innovative and restless farmer; and many believe to have found the ultimate truth. The Swiss Brown Cattle Breeders' Federation has the task to harmonise these different views and to show the way to the future at the right time. The accomplishment of this difficult task is a challenge for the responsible people and does not allow them to linger in their endeavour to keep the Brown Cattle competitive.

The present publication is a concise cross-section of the history of Brown Cattle breeding in Switzerland and represents an account of the present breeding activities written by many authors. The member of the board, Markus Harder who has designed the jubilee publication has coordinated the different contributions and followed the development of this publication with expert knowledge.

The publication, rich in photos, graphics and diagrams, is particularly well designed and full of useful information, summarising



the first centenary of the Brown Cattle Breeders' Federation. The present jubilee publication should not be anything more than just what it is, a celebration paper. It should stimulate the readers to deal with Brown Cattle breeding, bring about enjoyment and finally make the authors ponder further on the task of animal breeding.

The book is written in English, German, French and Italian.

Commercialisation of indigenous goat production and products in South Africa

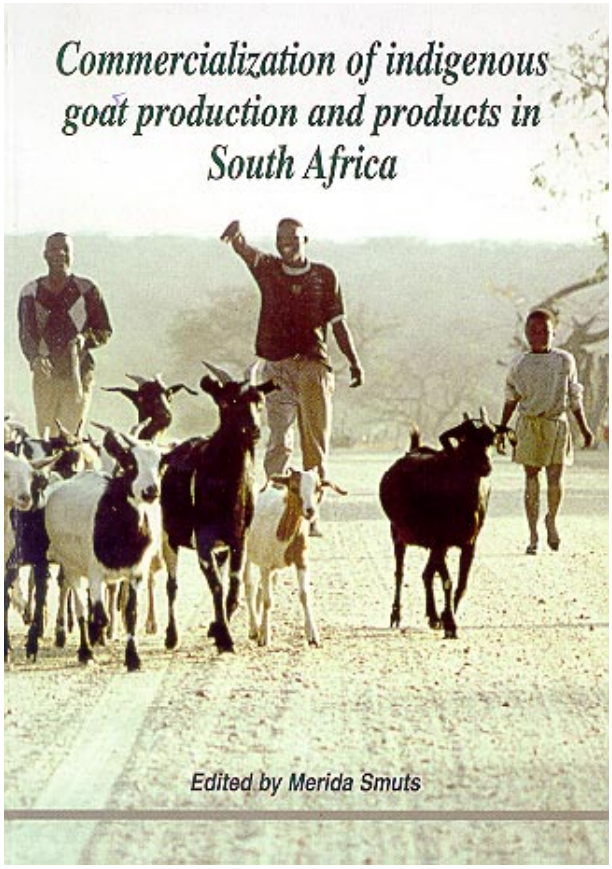
Editor: M. Smuts
Proceedings of a Workshop held in the Animal Nutrition and Products Institute of A.R.C., Irene, South Africa , 24 June 1997.
Advisory Bureau for Development, Aries Street, Waterkloof Ridge, 0181 Pretoria, South Africa
pp. 129

Published in 1998, this booklet of 130 pages summarises the proceedings of a workshop held at the Irene based National Institute for Animal Nutrition and Products. A total of 57 academics, scientists and technicians attended and presented a vast panorama of the state of the art of the goat sector in South Africa: research, economic, social management and diseases, breeding, selection feeding and marketing factors.

The very broad spectrum of South Africa's goat sector, from cashmere to hair, from skin and leather to handcrafts, from milk production to meat boer goat is presented and clearly exposed in this interesting publication.

Both large scale and communal farming are presented and discussed and the role of the various breeds, types and systems communities described. In fact, nearly 2/3 of the total goat population is found in the region where the workshop was organised.

The reason for holding this workshop lies in a collective wish to take stock and to try and coordinate the work that has, and still needs to be done, whether in research, extension and training. And secondly, it also follows from a decision made by a meeting of the Agricultural Committee Working Group of the USA -RSA Binational Commission. This working group proposed that a plan should be set which will provide for the whole process of the development of small-scale goat farming.



First National Congress of the Spanish Society on Animal Genetic Resources (SERGA)

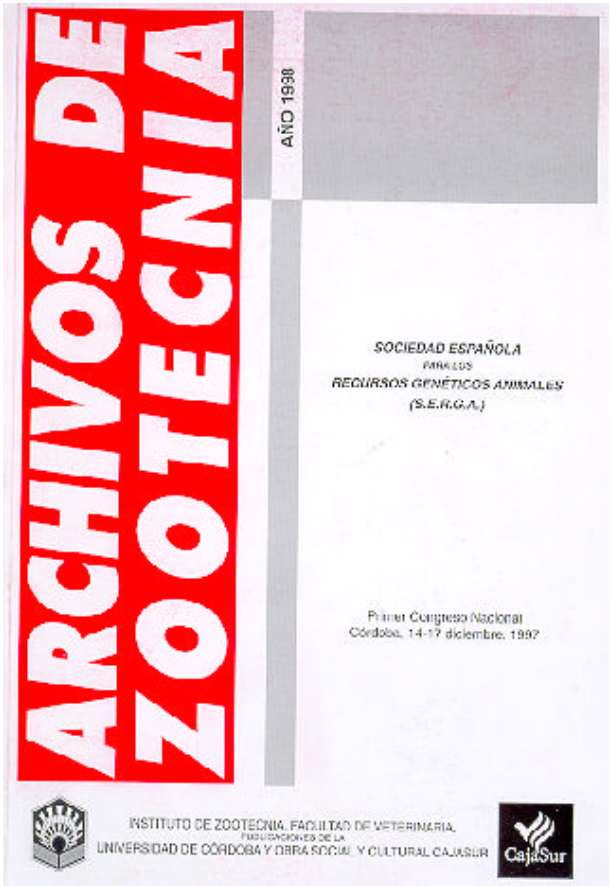
Proceedings of the firs SERGA Congress held in Cordoba, Spain on the 14-17 December 1997.
Suppl. Archivos de Zootecnia, 1998
Instituto de Zootecnia. Facultad de Veterinaria, Avda. Medina Azara 9, 14005 Cordoba, Spain
Tel.: +34-957-218743; Fax: +34-957-218666;
e-mail: Pa1gocag@lucano.yco.es
(In Spanish)
pp. 600

This large publication covers the full proceedings of the 1st Congress of the Spanish Society on Animal Genetic Resources (SERGA). The Congress was part of the celebration of the 150th Anniversary of the foundation of the veterinary centre of Cordoba and the 25th Anniversary of the constitution of the University of Cordoba.

The Congress was opened by an invited speech on "Disease threats to genetic conservation: BSE in Britain" by Lawrence Alderson and 80 communications (papers, short communications and posters) were proposed in three consecutive sessions:

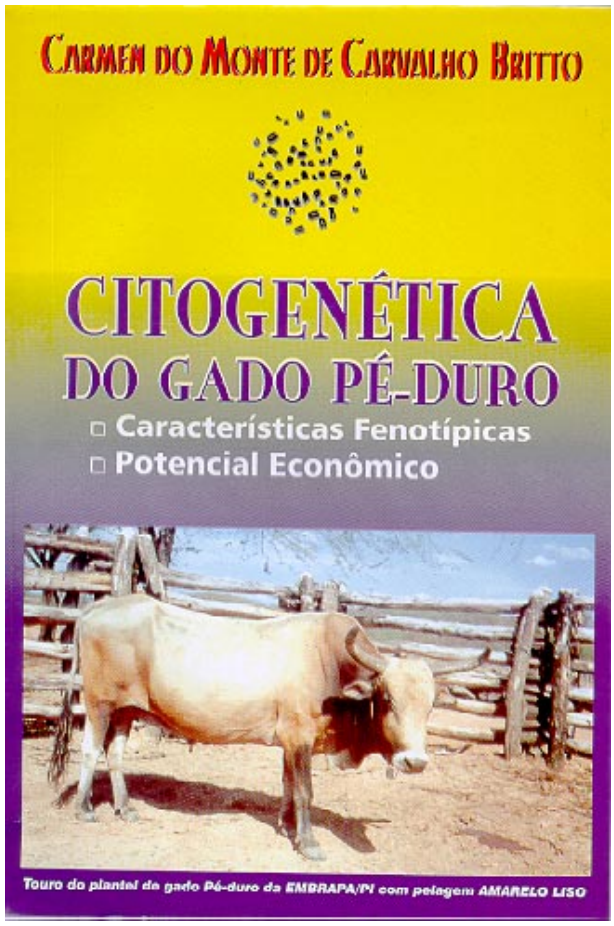
- Genetic and conservation plans;
- Reproduction;
- Ethnozootechnics and breed characterisation.

Thess important proceedings covers successfully the full spectrum of Animal Genetic Resources in the Spanish provinces, from ruminants to deers and rabbits and from bees to swine, dogs and equides.
Some additional information from Latin America (Mexico, Uruguay Argentina etc.…) are also presented.



Citogenética do Gado Pé-Duro. Características fenotípicas, potencial econômico (Cytogenetics of Pe-Duro cattle. Phenotipic characteristics and economic potential)

Ed.: Carmen do Monte de Carvalho Britto
EDUFPI, 1998
(In Portuguese)
pp. 95



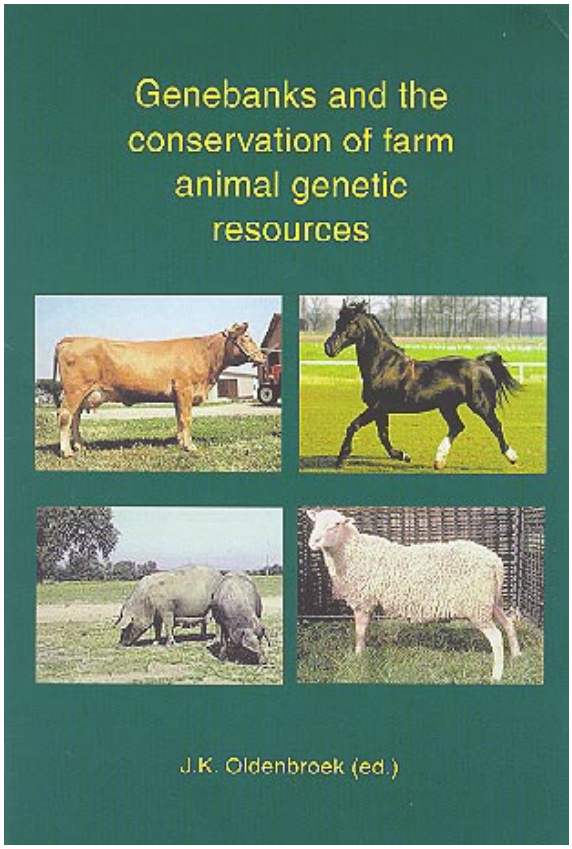
This short booklet gives details on the cytogenetic, phenotypic characteristics and economic potential of the Brazilian Pé-Duro cattle breed.

After a brief summ-up of its origin, differentiation from the other national breeds (like Criollo, Pantaneiro, Caracu, Franqueiro etc…) and actually conservation efforts (performed by EMBRAPA), the author shows her studies carried out on the breed for the characterisation of the genomic pattern.

Photos of Pé-duro chromosomes illustrate its peculiarities and its phylogenetic relationship with the European breeds; also the similarities with other domestic breeds by means of clear reconstruction of the genetic material are shown.

Genebanks and the conservation of farm animal genetic resources

Ed.: J.K. Oldenbroek
DLO, Institute for Animal Science and Health, P.O. Box 65, 8200 AB Lelystad, The Netherlands
ISBN 90-75124-06-6
pp. 120



Economic, social and environmental developments were the driving force for the selection of high productive breeds to be used in the intensive animal production systems. This selection decreased the contribution of locally developed breeds with lower-input, lower-output levels to food production and threatened the existence of these breeds.

So far, several organisations were active in the field of conserving animal genetic resources, e.g. the European Association for Animal Production (EAAP) and the Food and Agricultural Organisation of the United Nations (FAO). This book can be seen as an addition to the work published by EAAP and FAO, especially as an addition to the "Primary Guidelines for Development of National Farm Animal Genetic Resources Management Plans" of FAO published in 1998.

Within the Concerted Action BI04-CT96-0197 three meetings were held in 1997 and 1998 in which several aspects of conservation of genetic variation in farm animal populations in Europe were presented and discussed in order to develop guidelines for the cryoconservation of farm animal genetic diversity. Much attention was paid to the integration of the *ex situ* conservation in a genebank in programs for *in situ* conservation in EU circumstances. Geneticists from Scotland, Norway, Finland, France, Italy, Spain, The Netherlands and from FAO participated in these meetings. In a fourth meeting in 1998 they synthesised these aspects and discussions for publication in this book.

The readers of the book might be people working in education, in research, in animal breeding and in governmental and non-governmental organisations. This book will help them to stimulate awareness for the problems resulting from the extinction of breeds and create awareness for the opportunities of conservation of genetic diversity within species by the creation and use of genebanks and management of farm animal genetic resources in the EC.

The contents of the book will help people, who should make decisions on conservation activities for farm animals, to found their viewpoints.

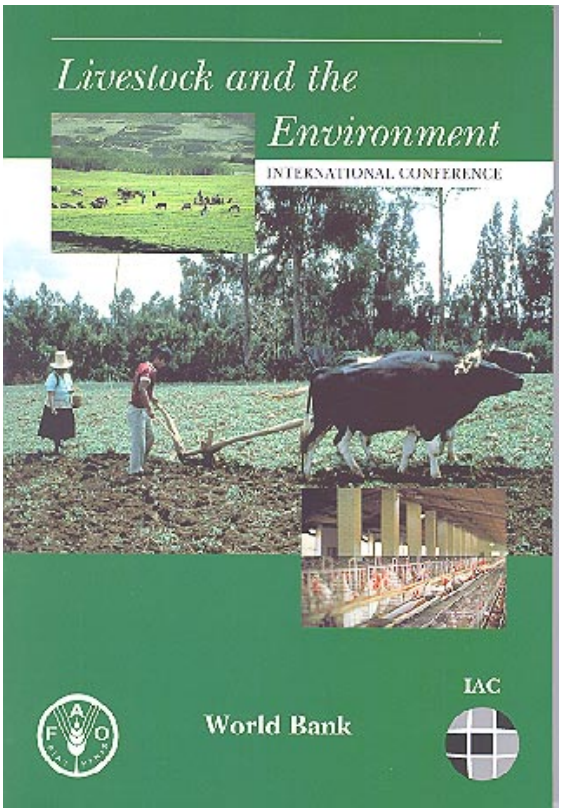
Livestock and the environment

Ed.: A.J. Nell
International Agricultural Centre, P.O. Box 88, 6700 AB
Wageningen, The Netherlands
Tel.: +31-317-490111; fax: +31-317-418552; e-mail: iac@iac.agro.nl
ISBN 90-70785-14-5

One of the greatest challenges faced by mankind is to satisfy the needs of the fast growing global population and at the same time preserve land, water, air and biodiversity resources. Livestock are a crucial element in this balancing process. Demand for livestock products is growing fast. Livestock, through their multiple functions, are a cornerstone of the livelihood of most of the rural population in the developing world. On the other hand, livestock use around 60 percent of the world's land area, including one fifth of the world's crop lands, and therefore interact directly and indirectly with a large part of the world's natural resources. Positioning livestock in such a way that it can satisfy future demands, while preserving the natural resource base. is therefore a critical element of sustainable agricultural development.

With this challenge in mind, a group of bilateral and multilateral development agencies requested FAO, the World Bank and USAID to lead the preparation of a major study on livestock - environment interactions. With the help of the international scientific community a state - of - the - art review on livestock - environment interactions has been prepared. The International Conference on Livestock and the Environment was held to share this information with a much broader audience and to translate the information into concrete guidelines for regional and national policies. The International Conference further aimed at formulating follow - up actions and identifying pilot activities to test innovative approaches.

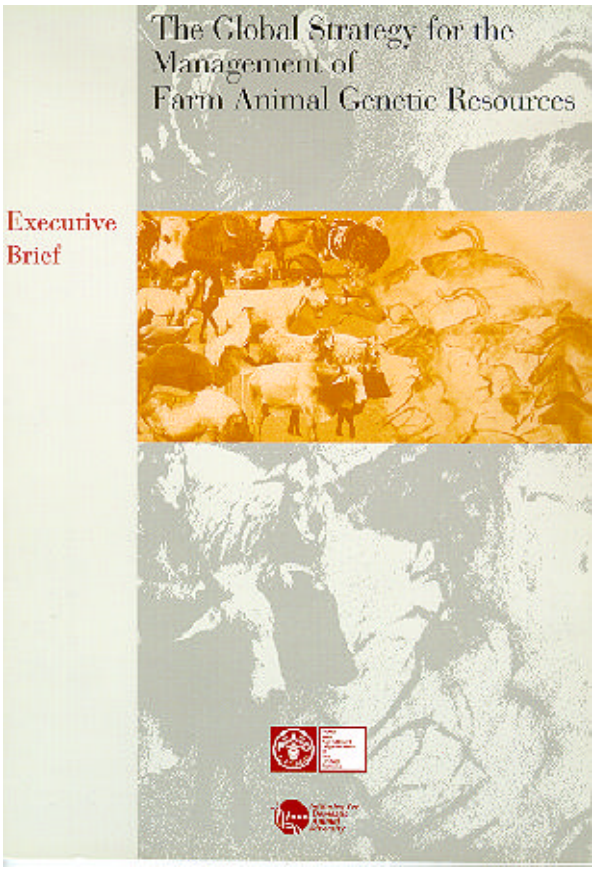
The proceedings of this conference contain the papers presented, and the conclusions and recommendations of the conference workshops. The recommendations will serve as a guideline for the Steering Committee of the Livestock - Environment Initiative to initiate follow - up action. A translation of the recommendations into Spanish and French is also included in the proceedings.



The Global Strategy for the Management of Farm Animal Genetic Resources: Executive Brief

Published by FAO, 1999,pp 43,
ISBN 92-5-104267-5

This easy to read quality-print publication is intended for the non-specialised reader. It explains through text and many charts, photos and boxes the FAO Global Strategy for the Management of Farm Animal Genetic Resources, its justifications, constituents and mechanisms. The document defines what are the farm avian and animal genetic resources being considered by the Global Strategy and describes their role in satisfying human needs. It highlights the need to sustain biodiversity among and within these genetic resources for the sustainable development of agriculture and for food security. The publication includes a glossary of terms frequently used in the field of biodiversity especially for animal and avian genetic resources.



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. Alternatively a manuscript may be sent as a WinWord Electronic Mail attachment to < agri@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.:

Cockril, 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

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 recommendations 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 comprises 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 recommendations 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; et seront envoyés à l'éditeur de AGRI, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italie. L'autre possibilité est d'envoyer l'article par courrier électronique avec le document adjoint en version WinWord à <agri@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 comprises 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 fax, e-mail, etc. avec l'auteur principal. Le titre abrégé ne devra pas dépasser les 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 les 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 des notes à pied de page pour chacun des auteurs après avoir laissé un espace en blanc après les noms. Chaque note de pied de page sera numérotée. On laissera deux espaces en blanc après les adresses.

Titres

Les titres de chaque chapitre, par example Résumé, Introduction, etc. seront alignés à gauche. Laisser deux espaces en blanc entre les notes de pied 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 qui fasse 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 pied 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 nécessaires. Ne pas utiliser les tabs ou la barre de séparation 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. Example 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.:

Cockril, 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

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 la Convención sobre la Biodiversidad.

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 medio 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 sobre Internet, en el sito: <<http://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 tener 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. Otra posibilidad es enviar el artículo por correo electrónico adjuntando el documento en versión WinWord a <agri@fao.org>. Las fotografías, a 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, e-mail, 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 viene escrito 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 vendrá indicada numéricamente. Se dejarán dos líneas en blanco después de las direcciones.

Títulos

Los títulos de cada sección, por ejemplo Resumen, Introducción, etc., vienen 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 ira 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 numero 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 trata 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.:

Cockril, 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 sito 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

Corrigendum

AGRI 25, J.E.O. Rege, page 2: figure 1 to be corrected to:

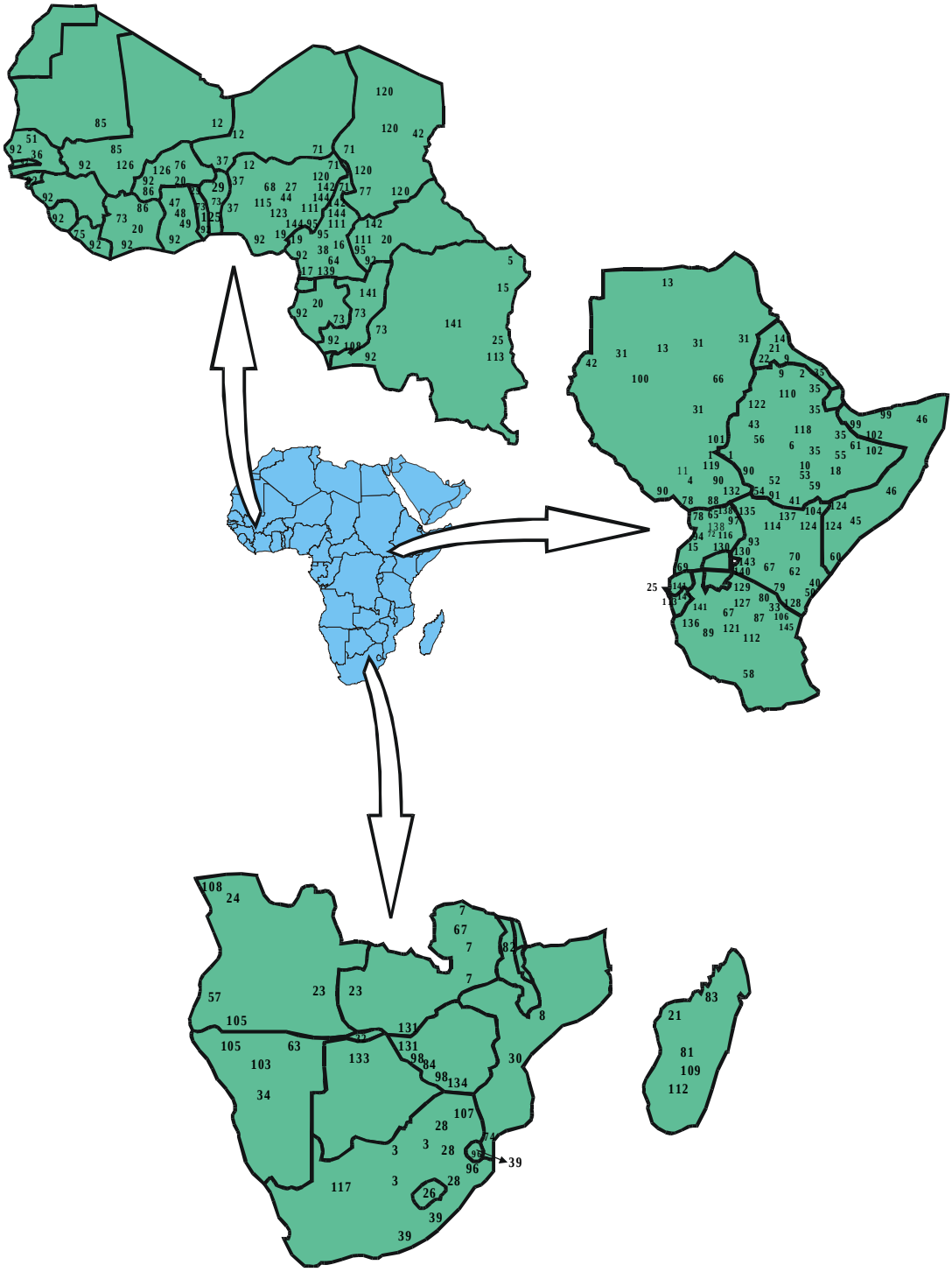


Figure 1. Distribution of cattle breeds in some African countries.

AGRI 25, J.S.F. Barker, page 37: table 3 to be corrected to:

Table 3. Correlation coefficients among genetic distances estimated from data on 21 microsatellite loci or 25 protein coding loci.

	Microsatellites			Protein Coding		
	Nei D	D_A	Delta mu	Reynolds	Nei D	D_A
Reynolds	.921	.911	.748	.831	.773	.798
Nei D		.991	.890	.754	.774	.772
D_A			.897	.748	.771	.783
Delta mu				.738	.797	.772
Reynolds					.929	.965
Nei D						.937

All significant, $P < 0.001$

AGRI 25, J.S.F. Barker, page 41, column 1, lines 35 and 40: FST to be corrected to: F_{ST}.
page 41, column 1, line 46: DA to be corrected to D_A

AGRI 25, D.L. Simon, page 78, column 2: sequence of the years must be corrected to:

1979 Animal breeding scientists propose a definition of the status of endangerment of breeds and criteria for conservation of endangered breeds (Deutsche Gesellschaft für Züchtungskunde,1979).

1979 Foundation of the Nordic Working Party on Animal Gene Banks for the Scandinavian countries (Maijala *et al.*,1992).

1980 Set-up of the Working Group on Animal Genetic Resources (EAAP-WGAGR) by the Commission on Animal Genetics of the European Association for Animal Production.

1983 Survey by the EAAP-WGAGR on breeds and country populations in Europe (Maijala et al.,1984).

1987 Set-up of the EAAP Animal Genetic Data Bank (EAAP-AGDB) at the Institute of Animal Breeding and Genetics, Hanover (Simon, 1990).

1992 Commission of European Communities 'Workshop and Training Course on data collection, conservation and use of animal genetic resources' in Hanover.

1993 EAAP-publication No. 66 'Genetic diversity of European livestock breeds', with status of endangerment and formation of groups of similar breeds.

1994 Nomination of National Focal Points in FAO Member-Countries of Europe as national co-ordinators for conservation of FAGR.

1996 INTERNET presentation of information of European breeds by the EAAP-Animal Genetic Data Bank, Hanover, and INTERNET-presentation of information of the FAO Domestic Animal Information System DAD-IS, Rome.