24
1998

# ANIMAL GENETIC RESOURCES INFORMATION

# BULLETIN D'INFORMATION SUR LE RESSOURCES GÉNÉTIQUES ANIMALES

# BOLETIN DE INFORMACION SOBRE RECURSOS GENETICOS ANIMALES

Food and Agriculture Organization of the United Nations
Organisation des Nations Unies pour l'alimentation et l'agriculture
Organización de las Naciones Unidas para la Agricultura y la Alimentatción

UNEP

Initiative for Domestic Animal Diversity
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

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

ANIMAL GENETIC RESOURCES INFORMATION will be sent free of charge to those concerned with the sustainable development conservation of domestic livestock. Anyone wishing to receive it regularly should send their name and address to the Editor, at the address shown above.
AGRI can also be found in the "Library" of DAD-IS at URL http//www.fao.org/dad-is.

**Le Bulletin d'information sur les ressources génétiques animales** est publié sous les auspices conjoints de l'Organisation des Nations Unies pour l'Alimentation et l'Agriculture (FAO) et du Programme des Nations Unies pour l'Environnement (UNEP). Cette publication est éditée par le Groupe des Ressources Génétiques de la Division de la Production et de la Santé Animales de la FAO. On peut se le procurer directement au siège de la FAO ou auprès des dépositaires et agents habituels de vente de publication de l'Organisation.

LE BULLETIN D'INFORMATION SUR LES RESSOURCES GÉNÉTIQUES ANIMALES sera envoyé gratuitement aux personnes intéressées par le développement durable et la conservation du bétail domestique. Les personnes souhaitant recevoir cette publication régulièrement voudront bien faire parvenir leurs nom et adresse à l'éditeur, à l'adresse sus-indiquée.
AGRI peut être consulté également sur la "Librairie" de DAD-IS de URL http//www.fao.org/dad-is.

**El Boletín de Información sobre Recursos Genéticos Animales** se publica bajo les auspicios de la Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO) y del Programa de la Naciones Unidas para el Medio Ambiente (UNEP). Se edita en el Grupo de Recursos Genéticos de la Dirección de Producción y Sanidad Animal de la FAO. Se puede obtener directamente de la FAO o a través de sus agentes de venta habituales.

El BOLETIN DE INFORMACION SOBRE RECURSOS GENETICOS ANIMALES será enviado gratuitamente a quienes estén interesados en el desarrollo sostenible y la conservación del ganado doméstico. Si se desea recibirlo regularmente, se ruega comunicar nombre, apellido y dirección al editor a la dirección arriba indicada.
AGRI puede consultarse también en la "Librería" de DAD-IS de URL http// www.fao.org/dad-is.

# *ANIMAL GENETIC RESOURCES INFORMATION*

# *BULLETIN D'INFORMATION SUR LES RESSOURCES GENETIQUES ANIMALES*

# *BOLETIN DE INFORMACION SOBRE RECURSOS GENETICOS ANIMALES*

**24**
**1998**

## CONTENTS



**FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS**
**ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE**
**ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION**

**UNITED NATIONS ENVIRONMENT PROGRAMME**
**PROGRAMME DES NATIONS UNIES POUR L'ENVIRONNEMENT**
**PROGRAMA DE LAS NACIONES UNIDAS PARA EL MEDIO AMBIENTE**

# Editorial

## Recent Developments in the Global Strategy for the Management of Animal Genetic Resources

FAO has, since the early 1960s , provided technical assistance to countries to identify and better manage their animal genetic resources and develop conservation strategies. In 1993 the Global Strategy for the Management of Farm Animal Genetic Resources (Global Strategy) was initiated with its technical and structural constituents. Since the early nineties serious efforts have been and are being made to institutionalise the activities in farm animal genetic resources at the country and global levels. This entails not only technical activities but also establishing structures, and institutions that will enhance discussion and decision making among formal and informal bodies with regard to animal genetic resources (AnGR). Within FAO this process has to go through different governing bodies composed of its over 170 member nations.

FAO has had a Commission on Plant Genetic Resources that was broadened in 1995 to include other organisms used for food and agriculture, beginning with animal genetic resources. At the Seventh Session of the Commission on Genetic Resources for Food and Agriculture, in May 1997, the Commission agreed to establish a subsidiary Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture (ITGW), i.e. the first AnGR intergovernmental structure to ensure direct government involvement and continuity and support. The first ITWG session was successfully held in 8-10 September 1998 at FAO, Rome, to consider the Further development of the Global Strategy for the Management of Farm Animal Genetic Resources (AnGR). The ITGW is composed of 27 countries elected to ensure regional balance. The session was well attended by 64 member and observer countries plus many international, regional and non-governmental organisations. The convenors reached recommendations that could be summarised in:

- further shape and develop the Global Strategy constituents;
- countries to urgently identify AnGR National Focal Points/Co-ordinators and Regional Focal Points to facilitate/co-ordinate network development and action; and
- FAO to co-ordinate a Country-driven *Report on The State of the World's Animal Genetic Resources*.

Thus a significant step has been taken for the countries to develop ownership of the Global Strategy.

The Editors

# Editorial

## Progrès récents dans la Stratégie Mondiale pour la Gestion des Ressources Génétiques Animales

Depuis le début des années 60 la FAO a donné son assistance technique aux pays pour identifier et obtenir une meilleure gestion de leurs ressources génétiques animales et pour développer des estratégies de conservation. En 1993 on a commencé la Stratégie Mondiale pour la Gestion des Ressources Génétiques des Animaux Domestiques (Stratégie Mondiale) avec les parties techniques et structurelles.

Dès le début des années 90 des efforts importants ont été réalisés, et encore aujourd'hui, pour institutionnaliser les activités dans le domaine des ressources génétiques des animaux domestiques au niveau national et international. Tout ceci entraîne, non seulement une série d'activités techniques, mais aussi l'établissement de structures et d'institutions qui puissent permettre la discussion et la prise de décision des organismes, officiels ou non, pour tout ce qui concerne les ressources génétiques animales (AnGR). A l'intérieur de la FAO ce processus doit passer à travers les différents corps gouvernementaux appartenants aux 170 pays membres.

La FAO comptait déjà avec une Commission pour les Ressources Génétiques Végétales qui, en 1995, a été élargie pour inclure d'autres organismes chargés des aliments et de l'agriculture, à commencer par les ressources génétiques animales. Pendant la Septième Séance de la Commission pour les Ressources Génétiques Alimentaires et de l'Agriculture, en mai 1997, la Commission a accordé d'établir un Groupe Technique de Travail Intergouvernemental subsidiaire pour les Ressources Génétiques Animales pour l'Alimentation et l'Agriculture (ITWG); par exemple, la première structure intergouvernementale de AnGR pour assurer le compromis au niveau gouvernemental, ainsi que la continuité et l'appui nécessaires. La première séance du ITWG a été organisée avec succès au siège de la FAO à Rome du 8 au 10 septembre 1998, et a pris en considération le Futur développement de la Stratégie Mondiale pour la Gestion des Ressources Génétiques des Animaux Domestiques (AnGR). Le ITWG est formé par 27 pays élus de façon équilibrés par rapport aux différentes régions. A la séance ont participés 64 pays membres, d'autres pays en tant qu'observateurs, ainsi que des organisations internationales, régionales et non gouvernementales. Le groupe a émis une série de recommandations qui peuvent être résumes comme suit:

- continuer avec le développement et modélation des composantes de la Stratégie Mondiale;
- que les pays identifient au plus tôt les Point Focaux Nationaux pour AnGR/facilitent les Coordonnateurs et les Points Focaux Régionaux/coordonnent le développement et travail du réseau; et
- que la FAO coordonne pour chaque pays un *Rapport sur l'Etat des Ressources Génétiques Animales dans le Monde*.

En conclusion, un pas important a été fait pour que les pays puissent réaliser le développement de leur propre Stratégie Mondiale.

Les Editeurs

# Editorial

## Progresos recientes en la Estrategia Mundial para la Gestión de los Recursos Genéticos Animales

Desde el inicio de los años 60 la FAO ha proporcionado asistencia técnica a los países para identificar y conseguir una mejor gestión de sus recursos genéticos animales y para desarrollar estrategias de conservación. En 1993 se inició la Estrategia Mundial para la Gestión de los Recursos Genéticos de Animales Domésticos (Estrategia Mundial) en sus partes técnicas y estructurales. Desde principios de los años 90 se han ido realizando, y se siguen haciendo, importantes esfuerzos para institucionalizar las actividades en el campo de los recursos genéticos de los animales domésticos a nivel nacional e internacional. Todo esto conlleva no sólo actividades técnicas, sino también el establecimiento de estructuras e instituciones que permitan la discusión y la toma de deciones de los organismos, oficiales o no, en todo lo que concierne los recursos genéticos animales (AnGR). Dentro de la FAO, este proceso tiene que pasar a través de diversos cuerpos gobernativos pertenencientes a los 170 países miembros.

La FAO contaba ya con una Comisión para Recursos Genéticos Vegetales que en 1995 fue ampliada para incluir otros organismos que se encargaban de los alimentos y de la agricultura, empezando con los recursos genéticos animales. Durante la Séptima Sesión de la Comisión para los Recursos Genéticos Alimentarios y de la Agricultura, en mayo de 1997, la Comisión acordó establecer un Grupo Técnico de Trabajo Intergubernamental subsidiario sobre Recursos Genéticos Animales para la Alimentación y la Agricultura (ITGW), por ejemplo, la primera estructura intergubernamental de AnGR para asegurar el compromiso a nivel gubernamental, así como la continuidad y apoyo necesarios. La primera sesión del ITWG se llevó a cabo con éxito en la sede de la FAO en Roma del 8 al 10 de septiembre de 1998, y tomó en consideración el Futuro desarrollo de la Estrategia Mundial para la Gestión de los Recursos Genéticos de Animales Domésticos (AnGR). El ITWG está compuesto por 27 países elegidos de forma equilibrada con respecto a las diferentes regiones. A la sesión asistieron 64 miembros y países observadores, así como organizaciones internacionales, regionales y no gubernamentales. El grupo emitió una serie de recomendaciones que pueden resumirse como sigue:

- seguir con el desarrollo y remodelación de los componentes de la Estrategia Mundial;
- que los países identifiquen urgentemente los Puntos Focales Nacionales para AnGR/faciliten los Coordinadores y Puntos Focales Regionales/coordinen el desarrollo y actuación de la red; y
- que la FAO coordine para cada país un *Informe sobre el Estado de los Recursos Genéticos Animales en el Mundo*.

En conclusión, un paso importante ha sido realizado para que los países lleven a cabo el desarrollo de su propia Estrategia Mundial.

Los Edirores

# El ganado criollo Romosinuano (Romo)

***G. Martínez Correal***

*Instituto Colombiano Agropecuario (ICA) Apartado Aéreo 2011*
***Villavicencio**, Meta, Colombia S.A.*

## Resumen

Este artículo reseña el origen del ganado criollo colombiano Romosinuano (Romo), el Valle del río Sinú, Costa Norte de Colombia. También, se describen las características zootécnicas de la raza, sus cualidades y aptitudes productivas como raza pura y en cruzamientos. Se presentan los resultados de heterosis, individual y materna, de características de crecimiento pre y posdestete, el cálculo de producción de carne al destete por vaca expuesta a toro en el hato, el peso presacrificio y el rendimiento en canal del Romo puro y sus cruces con Cebú (Brahman) y Charolais.

## Summary

This paper outlines the origin of the Colombian Creole cattle Romosinuano (Romo) in the Sinu Valley, North Coast of Colombia. The zootechnical characteristics of the breed, its qualities and productive aptitudes as a pure breed and as a crossbreed are also described. The individual and maternal heterosis of pre and post-weaning growth traits, the estimation of beef production at weaning per cow exposed in the breeding herd, the pre-slaughter weight and dressing percentage of Romo and its crosses with Zebu (Brahman) and Charolais are presented.

***Key words:*** *Criollo breeds, Colombia, Zebù, Beef cattle, Heterosis, Crossbreeding.*

## Introducción

El ganado criollo Romosinuano debe su nombre a la carencia de cuernos (topo o romo) y lugar de origen, el Valle del río Sinú, Costa Norte de Colombia. El Valle del Sinú, en su parte baja, corresponde a la zona climatológica de Bosque Seco Tropical (BST), con temperatura media de 27,5ºC; 83% de humedad relativa y 1 200 milímetros (mm) de precipitación anual, distribuidos en dos épocas: una de baja (diciembre a marzo) y otra de alta precipitación (abril a noviembre) (Hernández, 1976b).

Con extensión aproximada de 425 000 ha, el Sinú es un valle fértil con suelos profundos de textura franco-arcillosa, ricos en N, P, Ca K y con pH cercano a la neutralidad. Debido a su perfil plano y baja permeabilidad, el principal problema de sus suelos es su mal drenaje. Se encuentra cubierto por gran cantidad de gramíneas y leguminosas, nativas e introducidas. Las gramíneas introducidas más comunes son los pastos Pará (*Brachiaria mutica*), Pangola (*Digitaria decumbens*), Guinea (*Panicum maximum*), Angleton (*Dichantium aristatum*), Puntero (*Hiparrhenia rufa*) y *Brachiarias* spp, entre los que se destacan el *B. decumbens* y *B. dictyoneura*. El árbol forrajero más común es el Matarratón (*Gliricida sepium*) y entre las leguminosas nativas sobresalen las de los géneros *Desmodium* y *Phaseolus* (Pinzón, 1984).

El Ministerio de Agricultura de Colombia estableció, en 1936, un grupo de ganado Romo en la Granja de Montería, hoy conocida como Centro de Investigaciones (CI) Turipaná, (Cereté, Córdoba), con el propósito

*Figure 1. Vaca y ternera joven.*

*Figure 2. Grupo para apareamiento en un rancho de llanuras del este de Colombia.*

de conservar, multiplicar, fomentar y estudiar la raza. A partir de 1967 se iniciaron trabajos de evaluación productiva del Romo y sus híbridos con Cebú (Brahman), Charolais y Santa Gertrudis (Hernández, 1976b).

## Reseña Histórica

El primer ganado venido al Nuevo Mundo lo trajo Colón en su segundo viaje y se desembarcó en la isla de Santo Domingo, en noviembre de 1493. Dos décadas más tarde pasó a Puerto Rico, Jamaica, Cuba y territorio continental, dando origen al ganado de Norte, Centro y Sur América (Rouse, 1977). Santa Marta y Cartagena de Indias fueron los puertos de entrada del ganado a Colombia (Rouse, 1970; Salazar y Cardozo, 1981; Pinzón, 1984).

Sobre la carencia de cuernos de la raza existen varias teorías, todas ellas coinciden en que se originó de los ganados traídos al Nuevo Mundo por los conquistadores españoles. Según Pinzón (1981), ejemplares acornes se presentaban en forma esporádica en los ganados que poblaron el Sinú y aun cuando en un principio no gustaban, posteriormente se popularizaron, debido a que se asoció el rasgo topo o romo con mejores características para matadero. Pinzón considera que se presentó una mutación en el ganado criollo colombiano Costeño con Cuernos (CCC), oriundo de la zona y que por tanto el Romo es una raza criolla auténtica colombiana; la topización espontánea (mutación) se ha presentado en diversas razas y no habría razón para considerar que el carácter topo sea esencialmente producto de cruzamiento.

En Colombia existen otros casos de ganados criollos acornes que han aparecido espontáneamente y Martínez (1992) menciona una variedad "topa" en ganado criollo colombiano Blanco Orejinegro (BON).

Hernández (1976b) considera que la hipótesis más probable es la de cruzamiento de vacas de la raza criolla colombiana CCC con toros de razas sin cuernos, los cuales, debido a la dominancia genética de este rasgo y a la preferencia que se mostró por este tipo de animales, diseminaron rápidamente dicha

*Figure 3. Toro y vaca.*

*Figure 4. Vaca de ocho años de edad de 600 kg.*

característica. Las razas más probables en la formación del carácter tipo en el Romo, según la anterior hipótesis, son el Red Angus y el Red Poll.

Cualquiera que haya sido el origen del Romo, lo importante es el proceso de adaptación que ha experimentado en el amplio rango de ambientes y niveles de manejo a que ha sido sometido en distintas regiones de la geografía colombiana; el Romo es la raza criolla más difundida en el país y la única que ha sido exportada, inclusive a los Estados Unidos de Norte América. En el año de 1949 se llevaron unas pocas dosis de semen de Romo que fue utilizado en cruzamiento absorbente con ganado Hereford. Descendientes de los individuos llevados a los EE.UU. parecen ser los ancestros del ganado que posteriormente pasó al CATIE, Turrialba, Costa Rica (Pinzón, 1981).

Rico y col. (1986) reportaron, en 53 fincas de diferentes regiones de Colombia, una población total de 3 262 animales puros; además, 2 563, 2 665 y 264 individuos de alto (>75%), medio (0-50%) y bajo (<0-25%) mestizaje, respectivamente. La Asociación Colombiana de Criadores de Ganado Romosinuano (ASOROMO), reporta una tendencia al incremento de la población y las siguientes estadísticas de productores y número de animales en 1994: 6 000 animales registrados desde la creación de la Asociación y una población actual de 3 500 en 28 explotaciones en diferentes zonas del país. También reporta exportaciones a Venezuela de material seminal y, aproximadamente, 800 animales.

# Características Externas del Romosinuano

## Apariencia general

El rasgo más típico es la ausencia de cuernos. El color de la capa va de amarillo claro (bayo) a rojo encendido (castaño oscuro o cereza); también existen animales *hoscos:* bayos o castaños con cabeza y extremidades negras. El color de la capa es uniforme, pero algunos animales presentan pequeñas manchas circulares de color más intenso, esparcidas en todo el cuerpo y que le dan al animal un aspecto *moteado*, "*pataconeado*", como de tela estampada. Según el profesor J.C. Bonsma, citado por Pinzón (1981): "El moteado o estrellas de melanina o "pataconeado" sobre la piel es un indicador de alta vascularidad y buena salud. Esas estrellas son el resultado de una irrigación sanguínea muy eficiente".

Las mucosas y la piel son, en general, de tonos claros, pero en los hoscos estas son de color negro. La piel es gruesa y bien adherida, y el pelo es, corto, brillante y grasoso. El Romo es de talla mediana y cuerpo cilíndrico;

*Cuadro 1. Raza Romosinuano. Adaptado de: Hernández, B. G. (1976b); Rincón, R. (1991).*

| Medidas corporales (cm.) | Machos | Hembras |
|---|---|---|
| Alzada a la cruz | 131,5 | 123,5 |
| Perímetro torácico | 192,5 | 175,5 |
| Longitud escápulo-isquial | 159,5 | 145,5 |
| Peso vivo (kg) | 573,1 | 412,2 |

*Figure 5. Toro $F_1$ Romo x Brahaman heifer (RXB) de dos años y 400 kg .*

la raíz de la cola es descarnada, de inserción alta y escasa borla (Hernández, 1976b; Rincón, 1991). En el cuadro 1 se presentan los promedios no ponderados de pesos y medidas corporales de animales de cuatro (4) años de edad.

### Características fisiológicas

La característica fisiológica más sobresaliente del Romo es su adaptación al trópico, adaptación traducida en excelentes índices de fertilidad, supervivencia o longevidad; igualmente, sobresale por su rusticidad, habilidad combinatoria y producción de heterosis, especialmente con Cebú.

El sobresaliente comportamiento reproductivo que esta raza exhibe, no sólo en las condiciones del Sinú sino en otras regiones más inhóspitas del país, ha sido reportado por diferentes autores. En 1940, Escobar, citado por Pinzón (1981), encontró, en el Sinú, que el 79% de las vacas entraban en celo antes de los 60 días posparto y el 92% antes de los 69 días; posteriormente, Hernández (1970), en el C.I. Turipaná, reportó un promedio de 373,6 días de intervalo entre partos, con 54,3% de ellos inferiores a 365 días. Según Hernández (1981), la longevidad y fertilidad del ganado Romo compensan el aparente retraso en su desarrollo, ya que es común encontrar vacas de 15 ó más años de edad con 12 ó más partos, lo que es más económico que tener vacas de mayor velocidad de crecimiento, pero con menor número de crías en su vida productiva.

El Romo es tolerante a los excesos de calor y humedad del trópico, así como a otras contingencias desfavorables: excesiva presencia de parásitos externos e internos, plagas y enfermedades. Un aspecto importante de su adaptación a zonas húmedas es la calidad de las pezuñas, que lo habilitan para soportar el fango de las inundaciones periódicas en el Valle del Sinú (Pinzón, 1981).

## Resultados Experimentales

### Reproducción y supervivencia

Los resultados que se relacionan en los cuadros 2, 3, 4 y 5 corresponden a investigaciones realizadas en el C.I. Turipaná, durante los años 1970 a 1976. En el cuadro 2 se presentan las tasas de natalidad, mortalidad y destete, basadas en el total de vacas expuestas, en grupos de apareamiento de Romo (R) y Cebú (C) puros, sus recíprocos

*Cuadro 2. Porcentajes de natalidad, mortalidad y destete de cruces de Romo, Cebú, cruces recíprocos y retrocruces. Turipaná. 1970-1976. Adaptado de Hernández, B. G. (1976b; 1981).*

| Razas Toro Vaca | No. vacas | Natalidad % | Mortalidad % | Destete % |
|---|---|---|---|---|
| Romo Romo | 624 | 81,1 | 3,2 | 78,5 |
| Romo Cebú | 193 | 77,7 | 4,0 | 74,6 |
| Cebú Romo | 333 | 52,0 | 3,6 | 50,1 |
| Cebú Cebú | 493 | 74,4 | 8,2 | 68,3 |
| Romo $F_1$ CxR | 234 | 82,9 | 3,6 | 79,9 |
| Cebú $F_1$ RxC | 53 | 77,4 | 2,4 | 75,5 |

*Figure 6. Toro adulto de cinco años y 750 kg.*

RxC, CxR y retrocruces R(CxR) y C(RxC), durante una estación de monta de 90 días: de mayo a julio, los meses de mayor precipitación.

La natalidad promedia, 74,3%, es superior al promedio nacional, estimado en 50%. La mayor y menor tasas de natalidad se presentaron en los apareamientos de Romo por $F_1$ CxR (82,9%) y en el de Cebú por Romo (52%). Debido a la baja natalidad de este grupo de apareamiento, las vacas Romo (ambos grupos 66,6%) fueron superadas por las Cebú (76,1%).

Según Castro y col. (1971), el menor comportamiento reproductivo de vacas Romo con toros Cebú obedeció a un problema de "discriminación racial". Los autores reportaron que en los lotes de apareamiento mixtos (vacas Cebú y Romo con toro Cebú) las dos razas no se mezclaban y dicha situación condujo a que las vacas Romo en celo tuvieran menor oportunidad de ser servidas por el toro Cebú.

La mortalidad (3,4%) de terneros de vacas Romo se considera normal, con valor similar (3%) a la de terneros de vacas cruzadas $F_1$; mientras que la de terneros Cebú (8,2%) fue cercana al valor medio reportado para el país (10%) y duplica el promedio no ponderado de los restantes grupos (3,4%). Debido a los mayores y menores índices de natalidad y mortalidad de los grupos con toro Romo, estos produjeron la mayor tasa de destete, 75,4%.

## Crecimiento pre y posdestete de Romo

Los pesos promedios al nacer (PN) y destete (PD, ajustado a 270 días) de machos y hembras se presentan en el cuadro 3.

Los PN y PD se encuentran dentro del rango de valores reportados para otras razas criollas de Iberoamérica (Hernández, 1981; Plasse, 1983; Martínez, 1992). Los machos pesaron más al destete, aventajando a las hembras en 16,9 kg y no se presentó diferencia en el peso al nacer, 29,6 vs. 29,4 kg.

## Crecimiento pre y posdestete de Romo y cruces

Simultáneamente con los estudios de caracterización fenotípica del Romo, se llevó a cabo, en el C.I. Turipaná, un plan de cruzamiento alterno con Cebú y uso de toros Charolais en apareamiento terminal con hembras $F_1$ Romo por Cebú (RxC) y Cebú por Romo (CxR). En el cuadro 4 se resumen los pesos (kg) y ganancias diarias (g/día) pre (GDND) y posdestete (GDD-18) y los correspondientes valores de heterosis individual (hi) y materna (hm), que destacan la habilidad combinatoria de las tres razas.

Los valores de hi oscilaron entre 4,7 y 22,7%, para PN y GDD-18, respectivamente; valores similares a los reportados en estudios con razas criollas Iberoamericanas y cebuínas (Hernández, 1981; Plasse, 1983; Martínez, 1992) y superiores a los reportados para cruces entre razas europeas (*Bos taurus*) y éstas con Gyr y Brahman (*Bos indicus*), en regiones templadas de Norte América (Frahm y Marshall, 1985; Trail y col., 1985).

Las vacas $F_1$ CxR y RxC produjeron las progenies más pesadas al nacimiento, destete y 18 meses de edad, lo que coincide con la literatura sobre la mayor productividad de vacas híbridas de criollo y cebú (Hernández, 1976, 1981; Martínez 1992; Plasse, 1983; Holgado y Rabasa, 1985). Los valores de hm fluctuaron entre -9.3 y 14.2% para GDD-18 y GDN-D, respectivamente; el valor negativo para GDD-18 estaría indicando que, una vez terminado el efecto materno, habría pérdida de adaptación, por mayor proporción de genes europeos de los trihíbridos con Charolais.

En el cuadro 5 se presenta el cálculo de producción de carne al destete por vaca expuesta a toro en el hato, basado en el porcentaje y peso de destete. La mayor producción de carne, por vaca expuesta (kg/vaca), se presentó en los grupos de retrocruces: toro Romo con vacas $F_1$ CxR (181,6 kg) y toro Cebú con vacas $F_1$ RxC (172,2 kg); superando ampliamente el promedio nacional, estimado en 88 kg/vaca.

La menor productividad de vacas Romo con toro Cebú (105,3 kg) obedeció a la menor tasa de natalidad (52%, cuadro 2), ocasionada por la conducta discriminatoria del Cebú; sin embargo, debido al excelente peso de destete del $F_1$ CxR (210,1 kg), la producción por vaca superó en 17,3 kg/vaca la estimada como promedio nacional.

*Cuadro 3. Peso al nacimiento y destete de machos y hembras Romosinuano. Turipaná. 1959 a 1967. Adaptado de Hernández, B.G. (1970).*

| Detalle | Terneros nacidos | Peso nacimiento (kg) | Terneros destetados | Peso destete (kg) |
|---|---|---|---|---|
| Promedio general | 2 341 | 29,5 | 1 510 | 174,0 |
| Machos | 1 127 | 29,6 | 755 | 182,4 |
| Hembras | 1 114 | 29,4 | 755 | 165,5 |

*Cuadro 4. Heterosis individual (hi) y materna (hm) y promedios de pesos al nacer (PN), destete (PD) y 18 meses (P18m) y ganancias diarias predestete (GDND) y posdestete (GDD-18) de Romo, Cebú y cruces con Charolis (Ch). Turipaná. 1970-1974. Adaptado de Hernández, B.G. (1976). * $F_1$ = RxC y CxR.*

| Raza Toro | Raza Vaca | No. | PN (kg) | PD (kg) | P18m (kg) | GDN-D g/día | GDD-18 g/día |
|---|---|---|---|---|---|---|---|
| Romo | Romo | 417 | 29,58 | 170,5 | 244,7 | 521 | 273 |
| Romo | Cebú | 148 | 29,38 | 214,1 | 305,8 | 684 | 335 |
| Cebú | Romo | 127 | 32,04 | 210,1 | 326,0 | 658 | 421 |
| Cebú | Cebú | 261 | 29,06 | 204,5 | 296,4 | 649 | 342 |
| hi unidades | | | 1,39 | 24,6 | 45,3 | 86 | 70 |
| hi % | | | 4,70 | 13,1 | 16,7 | 14,7 | 22,7 |
| Ch | Romo | 46 | 33,64 | 203,5 | 279,1 | 628 | 281 |
| Ch | Cebú | 7 | 29,09 | 224,9 | 326,1 | 724 | 362 |
| Ch | $F_1$ * | 50 | 34,09 | 242,6 | 319,3 | 772 | 262 |
| Hm unidades | | | 2,73 | 28,4 | 16,7 | 96 | -59,5 |
| hm % | | | 8,70 | 13,2 | 5,5 | 14,2 | -9,3 |

*Cuadro 5. Producción de carne al destete por vaca expuesta a toro en el hato. Adaptado de Hernández, B.G. (1976, 1981).*

| Razas Toro Vaca | Destete % | Peso Destete (kg) | Produción carne (kg/vaca) |
|---|---|---|---|
| Romo Romo | 78,5 | 170,5 | 133,8 |
| Romo Cebú | 74,6 | 214,1 | 159,7 |
| Cebú Romo | 50,1 | 210,1 | 105,3 |
| Cebú Cebú | 68,3 | 204,5 | 139,6 |
| Romo $F_1$ CxR | 79,9 | 227,3 | 181,6 |
| Cebú $F_1$ RxC | 75,5 | 228,1 | 172,2 |

## Peso presacrificio y rendimiento en canal

Estudios de rendimiento carnicero, realizados en el C.I. Turipaná, Gómez y Acosta (1986) reportaron que los promedios de peso presacrificio (477 kg) y rendimiento en canal (56,7%) de novillos en pastoreo, Romo y sus cruces recíprocos $F_1$ con Cebú y $F_2$ (inter-sé), con 31 meses de edad media, fueron superiores a los valores estimados para el país: 48 meses, 400 kg y 55%, respectivamente. Los híbridos $F_1$ y $F_2$ superaron al Romo puro (420,3 kg, 52,6%) y el $F_1$ CxR (506 kg, 57.9%) aventajó en 29 kg y 1,2% el peso y rendimiento promedio de los restantes grupos cruzados y al Romo puro.

*Figure 7. Ternera de tres años primipara.*

## Resumen y Conclusiones

Por sus características de adaptación a las condiciones climáticas y de manejo del trópico húmedo, reflejadas en excelentes parámetros de reproducción y supervivencia y por su gran aporte a la producción de híbridos de extraordinarios rasgos productivos, tanto de crecimiento como maternos, factores indispensables para desarrollar sistemas de producción ganaderos eficientes, sostenibles y competitivos en las condiciones del trópico cálido húmedo, no sólo de Colombia sino de Iberoamérica, es necesario realizar esfuerzos ingentes, tendientes a asegurar la conservación, desarrollo y uso racional y estratégico de la raza criolla colombiana Romosinuano.

## Referencias

**Castro, A., Reyes, L.H.& Velasco, E.** 1971. Estudio sobre la discriminación racial de las razas Cebú y Romosinuano. Asoc. Lat. Prod. Anim. 6:178 (Memoria).

**Gómez S.J. & Acosta O.** 1986. La raza Romosinuana y sus cruces con Cebú. ICA. Mimeografiado, pp. 10.

**Hernández, B.G.** 1970. Effect of year, season, age of dam and sex of calf on calving interval and growth rate of Romosinuano cattle. M. Sc. Thesis. University of Nebraska, Lincoln, Ne., USA, pp. 140.

**Hernández, B.G.** 1976a. Genetic factors in beef cattle crosses in Colombia. Ph.D. Dissertation. Colorado State University, Fort Collins, Colorado. USA, pp. 163.

**Hernández, B.G.** 1976b. Romosinuano. Razas criollas colombianas. Manual de Asistencia Técnica. ICA (Col). No. 21: 1-16.

**Hernández, B.G.** 1981. Las razas criollas colombianas para la producción de carne. Recursos Genéticos animales en América Latina. Ganado Criollo y especies de altura. Roma, Italia, FAO, 22: 52.

**Martínez, C.G**. 1992a. Los bovinos criollos y su contribución a la producción de carne y leche. Memorias de la reunión técnica sobre conservación para el desarrollo de los recursos genéticos aninales en América Latina. CATIE (Costa Rica), pp. 156.

**Martínez, C.G.** 1992b. El ganado criollo colombiano Blanco Orejinegro (BON) Animal Genetic Resources Information. FAO. UNEP (Roma) 9: 33-44.

**Muñoz, H. & Martín, T.** 1969. Crecimiento antes y después de destete en ganado Santa Gertrudis, Brahman y Criollo y sus cruces recíprocos. Asoc. Lat. Prod. Anim. Alpa, 4: 7.

**Pinzón, M. E.** 1981. Vacuno Romosinuano. Suplemento ganadero. Banco Ganadero Santafé de Bogotá (Col). Vol 2: 2, pp. 60.

**Pinzón, M. E.** 1984. Historia de la ganadería bovina en Colombia. Suplemento ganadero. Banco Ganadero. Santafé de Bogotá (Col.) 4: (1): 208.

**Plasse, D.** 1981. El uso del ganado criollo en programas de cruzamiento para la producción de carne en América Latina. Recursos Genéticos animales en América Latina. Ganado criollo y especies de altura. Roma, Italia, FAO. 22: 77.

**Plasse, D.** 1983. Crossbreeding results from beef cattle in the Latin American tropics. Animal Breeding Abstracts. 51(11): 779.

**Rico, L.G. Bejarano, A.A. & Hernández, B.G.** 1986. Directorio de productores e inventario ganadero de las razas bovinas criollas y colombianas. Ministerio de Agricultura, I.C.A., Banco Ganadero, IICA. Bogotá, Col. pp. 129.

**Rouse, J.E.** 1977. The criollo: Spanish cattle in the Americas. Norman, USA; University of Oklahoma Press, pp. 303.

**Salazar, J.J. & Cardozo, A.** 1981. Desarrollo del ganado criollo en América Latina: resumen histórico y distribución actual. Recursos Genéticos animales en América Latina. Ganado Criollo y especies de altura. Roma, Italia, FAO 22: 8.

**Velázquez, Q.J.** 1975. Nueva Raza tropical colombiana de ganado vacuno. Col. pp. 70.

# Genetic resistance to endoparasites in sheep and goats. A review of genetic resistance to gastrointestinal nematode parasites in sheep and goats in the tropics and evidence for resistance in some sheep and goat breeds in sub-humid coastal Kenya

***R.L. Baker***

*International Livestock Research Institute (ILRI)*
*P.O. Box 30709, **Nairobi**, Kenya*

## Summary

The evidence for both between- and within- breed genetic variation for resistance to gastrointestinal (GI) nematode parasites is reviewed. It is concluded that much of the published research on breed characterisation for resistance suffers from poor experimental design. Prior to the initiation of a 6-year study that has just been completed in coastal Kenya there were no estimates of within-breed genetic variation (i.e. heritabilities) of resistance in sheep or goats in the tropics. This study has confirmed that Red Maasai sheep and Small East African (SEA) goats are more resistant to GI parasites (predominantly *Haemonchus contortus*) than Dorper sheep and Galla goats. Heritability estimates for logarithm transformed faecal egg counts (an indicator of resistance) in 8-month-old lambs was 0.18±0.08 for all lambs, but higher in the susceptible Dorper-sired lambs (0.35±0.16) than in the resistant Red Maasai-sired lambs (0.06±0.07). This difference in heritability suggests that many centuries of natural selection have fixed most of the genes for resistance in the Red Maasai sheep. The resistant Red Maasai sheep and SEA goats were two to three times more productive than the susceptible Dorper sheep and Galla goats in the sub-humid coastal Kenya environment.

## Resumen

Se presenta una revisión de la variación genética entre y dentro de las razas para la resistencia a los nematodos gastrointestinales (GI). Se concluye que mucha de la investigación publicada sobre la caracterización de las razas para la resistencia carecen de diseño experimental. Antes de iniciar el estudio de 6 años que acaba de concluirse en la costa del Kenya, no se encontraban estimaciones acerca de la variación genética dentro de la raza (por ejemplo la heredabilidad) para la resistencia en ovinos y caprinos en zonas del trópico. Este estudio ha confirmado que la raza ovina Red Maasai y la cabra Small East Africa (SEA) son más resistentes a los parasitos GI (sobre todo a *Haemonchus contortus*) que la oveja Dorper y la cabra Galla. La estimación de la heredabilidad del logaritmo transformado del número de huevos fecales (que es un indicador de resistencia) en corderos de 8 meses era de 0,18±0,8 para todos los corderos, pero era superior en los machos susceptibles de raza Dorper (0,35±0,16) en comparación con los corderos resistentes de raza Red Maasai (0,06±0,07). Esta diferencia en la heredabilidad sugiere que muchos siglos de selección natural han fijado muchos de los genes para la resistencia en la oveja Red Maasai. La raza Red Maasai y la cabra SEA eran de dos a tres veces más productivas que la oveja susceptible de raza Dorper y que la cabra Galla en un medio como la zona subhumida de la costa del Kenya.

***Key words:*** *Sheep, goats, genetic resistance, gastrointestinal parasites,* Haemonchus*, Kenya, Dorper sheep, Galla goats.*

# Introduction

Helminths constitute one of the most important constraints to ruminant livestock production in the tropics (Fabyi, 1987). Widespread infection with internal parasites in grazing animals, associated production losses, anthelmintic costs and death of infected animals are some of the major concerns. Current control methods focus on reducing contamination of pastures through anthelmintic treatment and/or controlled grazing. In the tropics, these methods are limited by the high costs of anthelmintics, their uncertain availability, increasing frequency of drug resistance (Waller, 1997) and limited scope in many communal farming systems for controlled grazing. An attractive sustainable solution is to utilise host genetic resistance for disease control.

There is a large and diverse range of indigenous sheep and goat breeds/populations in the tropics, some of which appear to have unique genetic ability to resist or tolerate diseases (Baker, 1995). This paper reviews the limited data available on both between- and within- breed genetic variation for resistance to helminthosis in sheep and goats in the tropics. Some of the results of an ILRI research project on genetics of resistance to gastrointestinal nematodes in small ruminants in sub-Saharan Africa are also presented.

# Criteria of Resistance, Resilience or Tolerance

Clunies-Ross (1932) was the first to recognise the need for the distinction between "resistance to infection" and "resistance to the effects of infestation". There is some confusion in the literature about how to define these effects, but the following definitions are commonly used (Albers *et al.*, 1987; ILCA, 1991).

**Resistance,** defined as the initiation and maintenance of responses provoked in the host to suppress the establishment of parasites and/or eliminate parasite load.

**Resilience or Tolerance**, defined as the ability of the host to survive and be productive in the face of parasite challenge.

For a number of reasons measurement of resistance appears more useful than measurement of resilience or tolerance. For example, tolerance or resilience does not imply control of the parasite and therefore contamination of pasture will increase because faecal egg output of the animals is not being reduced. With resistant animals, however, the contamination of pasture by infective larvae gradually decreases (Windon, 1990). However, it can also be noted that if parasites can adapt to anthelmintics, they can probably also adapt to resistant hosts. It has therefore been suggested that until it is known what occurs in parasite adaptation, it is better to select for resilience because there is no pressure being exerted on the parasite for genetic adaptation. Research to date suggests that genetic adaptation of parasites to resistant hosts may not be a major problem (Windon, 1991; Barger and Sutherst, 1991; Woolaston *et al.*, 1992).

# Parasites Species and Mode of Infection

Both natural pasture challenge and artificial (experimental) infections have been used in assessing resistance to endoparasites. There is a wide diversity of internal parasites and under natural challenge ruminants usually harbour more than one species (Gruner, 1991). These include the three major orders (Nematoda, Cestoda and Trematoda) and a range of genera within orders (Hansen and Perry, 1994). The life cycle, population biology and pathogenecity of the different species are not the same, but in most cases are relatively well known.

Nearly all the research to date on resistance to endoparasites has concentrated on the Nematodes and particularly the Trichostrongyles (e.g. *Haemonchus, Ostertagia*, *Trichostrongylus* and *Nematodirus* spp). There have been some reports in sheep of breeds resistant to *Fasciola hepatica* (Boyce *et al.*, 1987)

and *Fasciola gigantica* (Wiedosari and Copeman, 1990; Roberts *et al*., 1997a). While this review will concentrate on resistance to GI nematodes there is scope for further research on host genetic resistance to Trematodes (flukes), especially given the recent report of a major gene controlling resistance to *Fasciola gigantica* in Indonesian Thin Tail sheep (Roberts *et al*., 1997b).

In order to obtain meaningful results with natural infection it is first important to assess which are the most economically important parasites in any particular agro-climatic zone. When there is a diversity of parasites present then natural infection is preferred, particularly to assess breed differences. In assessing within breed genetic variation to obtain heritability and genetic correlation estimates then artificial infection is often preferred in experimental studies (Woolaston *et al.,* 1991; Woolaston and Eady, 1995), but natural infection is also commonly used both in experimental studies and commercial breeding programmes (Morris *et al.,* 1995). Usually artificial infection is with a single parasite species (e.g. *Haemonchus contortus* or *Trichostrongylus colubriformis*), although sometimes a mixed infection is given. When artificial infection is used, it is important to assess how this relates to resistance under natural pasture challenge. There is encouraging evidence that the genetic correlation between natural and artificial infections with GI nematodes in sheep is high and positive (Gray *et al*., 1991; Woolaston and Eady, 1995; Bouix *et al*., 1995).

Piper and Barger (1988) noted that artificial infection excludes any expression of genetic resistance due to the grazing behaviour of the host. They suggested that selection for resistance based on natural infection is to be preferred, as it makes fewer assumptions about the basis of host resistance. However, in those climates where there is marked variation between years or seasons in intensity of larval challenge on pasture, artificial infection may need to be included in conjunction with natural infection.

## Parameters to Be Measured

The most common trait measured to predict resistance to GI nematodes has been faecal egg count (FEC). Reservations have been expressed about the use of FEC as a measure of resistance to internal parasites (Dargie, 1982; Gruner, 1991). It has been noted that FEC is not always closely related to worm burdens and that FEC is affected by an array of host-parasite relationships such as level of host immunity, age of host, species of parasite, stage of infection, parturition and accuracy of faecal egg counting. Despite these reservations, a large volume of experimental evidence shows that FEC can be used to assess the resistance/susceptibility status within and between breeds and strains of sheep (Eady, 1995) and it is both a repeatable and heritable trait. While FEC is a useful indicator trait of resistance to GI nematodes, it is also a valuable trait in its own right as a measure of the degree to which an animal is contaminating pastures with worm eggs.

Packed red cell volume (PCV), a measure of anaemia, is another very useful indicator of host resistance to endoparasites, particularly for blood-sucking parasites such as *Haemonchus contortus* (Albers *et al*., 1987).

Worm counts are the best measure of resistance to GI nematodes but involve slaughtering the animal. Worm counts have been quite commonly measured in breed characterisation studies. However, worm counts as a measure of resistance cannot easily be used in within breed selection studies because potential candidates for selection have to be sacrificed to measure the worm counts. In theory it would be possible to use some form of family selection to utilise worm counts in selection programmes, but the cost of doing this is probably prohibitive. At least in young sheep less than one year of age, there is good evidence for a strong positive phenotypic correlation between FEC and worm burdens (McKenna, 1981; Morris *et al.,* 1995).

The immunological mechanisms and parameters which reflect the underlying genetic resistance could potentially be used as

phenotypic markers of resistance (Douch *et al*., 1996). However, to date, no immunological parameters have been identified that are better predictors of resistance than FEC.

Resilience is a more difficult trait to measure, because to obtain a measure of how much of an animal's production is affected by the parasites, it is necessary to record production with and without a challenge infection (Albers *et al*., 1987). An alternative method of measuring resilience which has been investigated in sheep, is based on anthelmintic treatment requirements (e.g. number of treatments in young lambs) while grazing infective pasture (Bisset *et al.,* 1994; Morris *et al*., 1995; Bisset and Morris, 1996).

## Genetic Variation for Disease Resistance

There is ample evidence that genetic variation for disease resistance in domestic animals exists (Owen and Axford, 1991). Genetic resistance to the important infectious diseases of domestic livestock is usually found to follow polygenic inheritance, as do the production traits. In this situation we are interested in estimating the magnitude of genetic variation both between breeds or strains and within breeds and ultimately utilising this genetic variation for resistance in breeding programmes (Woolaston and Baker, 1996).

## Breed Variation

There have been many reports since the mid-1930's of variation among breeds of sheep in resistance to internal parasites, particularly to *Haemonchus contortus, Ostertagia spp* and *Trichostrongylus spp*. Gray (1991) summarised 23 publications on this subject and this was expanded to 34 studies in a review by Baker *et al.*(1992). A number of indigenous 'unimproved' breeds of sheep in Africa (Red Maasai, Djallonke and Sabi), the Caribbean (St. Croix and Barbados Blackbelly), North America (Florida Native, Louisiana Native and Navajo) and India (Garole) appear to be relatively resistant or tolerant to GI nematodes. While there is less evidence for resistance among goat breeds, again the indigenous breeds (e.g. the Small East African and the West African Dwarf) appear to be more resistant (Baker *et al*., 1992, 1998a; Baker, 1995).

Nearly all the studies reviewed by Gray (1991), Baker *et al*. (1992) and Gray *et al*. (1995) are characterised by poor experimental design, both in terms of the numbers of animals of each breed tested, and the lack of information on how the breeds were sampled (Woolaston, 1997). In addition, very few of the studies took account of variation among sires within breeds. The magnitude of the between-sire differences can be of the same order as the largest of the between breed differences (Gray *et al*., 1987). Consequently, many of the breed differences reported could just reflect a single sire effect and hence should be interpreted cautiously.

While many of the publications on genetic variation for resistance in disease can be criticised in terms of experimental design, it is reassuring to note that some breeds have been identified as resistant in a number of independent studies. This applies particularly to the Florida Native, St. Croix and Red Maasai sheep breeds, and it is very likely these breeds have some real genetic resistance to internal parasites. It is worthy of note that the St. Croix sheep originated from West Africa and are probably related to the Djallonke sheep (Bradford and Fitzhugh, 1983), which are believed to be relatively resistant to endoparasites (Osinowo and Abubakar, 1988; Smith, 1988). Most of the breeds identified as being relatively resistant are native or 'unimproved' breeds. This presumably reflects the fact that these breeds have been under natural selection for a long time with little or no treatment with anthelmintic drugs.

## Heritabilities

In small ruminants most of the heritability estimates of resistance to endoparasites

(assessed in terms of either FEC or PCV) are from Merino or Romney sheep in Australasia (Gray and Woolaston, 1991; Gray *et al*.,1995). The average heritability for a single FEC measurement from estimates reviewed by Baker *et al*., (1992) was 0.32, while the average estimates for PCV was 0.35. The heritability of the mean of several (2 to 3) egg counts recorded in different infections increased to about 0.4 to 0.5. Heritabilities were similar for different modes of infection (natural and experimental), and for infections with different parasite genera (both single genus infections and mixed infections). In Africa, the few estimates of heritabilities and repeatabilities of resistance to endoparasites in sheep and goats are similar to those found in Australasia (Baker *et al*., 1992, 1994a, 1998b; Baker, 1995). There are no estimates of heritability of resilience to gastrointestinal nematodes in sheep or goats in the tropics but Australasian estimates are all low and range from 0.06 to 0.14 (Albers *et al.,* 1987; Bisset *et al*., 1994).

# ILRI's Research on Endoparasite Resistance

In 1991, the International Livestock Centre for Africa (ILCA - now ILRI) initiated a Pan-African research project to investigate more comprehensively than previous studies both between- and within-breed genetic resistance to GI nematode parasites in some indigenous breeds of sheep and goats in Kenya, Ethiopia, Senegal and Zimbabwe (ILCA, 1991). The research in Kenya and Ethiopia was completed in 1997. The research with sheep and goats in Kenya is reported here as an illustration of the type of experimental design employed and the results obtained (Baker *et al.,* 1994a, 1998a, 1998b).

# Kenya - Sheep

## Experimental design

This study was carried out at Diani Estate of Baobab Farms, 20 km south of Mombasa in the sub-humid coastal region of Kenya. In 1991, Dorper and Red Maasai x Dorper ($F_1$) ewes, and in 1992 and in subsequent years Dorper, $F_1$ and Red Maasai ewes were single—sire mated to 12 Red Maasai (Figure 1) and 12 Dorper (Figure 2) rams each year in a complete diallel to produce the six lamb genotypes shown in Table 1.

At least half of both the Dorper and Red Maasai rams used each year were replaced by new rams the next year. A total of 41 Dorper and 35 Red Maasai rams were used. The rams were obtained from a wide range of sources and districts in Kenya to ensure representative samples of each breed.

The ewes were weighed six times during the reproductive cycle: at mating; three

*Table 1. Number of single-born lambs alive at birth by genotype in 1991-96 at Diani Estate, Mombasa,Kenya.*

| Lamb breed (Sire breed x Dam breed) | Year of birth | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | Total |
| Dorper x Dorper (D) | 98 | 66 | 55 | 30 | 39 | 30 | 318 |
| Dorper x (RM x D) | 85 | 76 | 93 | 71 | 67 | 35 | 427 |
| Dorper x RM | | 7 | 38 | 25 | 27 | 27 | 124 |
| Red Maasai x D | 85 | 58 | 57 | 14 | 15 | 9 | 238 |
| Red Maasai x (RM x D) | 99 | 81 | 95 | 61 | 68 | 66 | 470 |
| Red Maasai x Red Maasai (RM) | | 8 | 34 | 48 | 64 | 64 | 218 |
| Total | 367 | 296 | 372 | 249 | 280 | 231 | 1795 |

*Figure 1. Red Maasai sheep.*

*Figure 2. Dorper sheep.*

months after mating; two weeks before lambing; and one, two and three months after lambing. Blood and faecal samples were collected from all ewes at each weighing. Blood was taken to determine packed cell volume (PCV), to measure anaemia, and was also examined for trypanosomes. Faecal egg counts (FEC), a measure of GI nematode infestation, were taken and faecal samples, bulked by breed, were cultured and parasite larvae present were identified. Ewes found to have a FEC greater than 4 000 egg per gram (epg) or a PCV less than 15% at any measurement time were treated with an anthelmintic drug.

Lambs were weighed as close to birth as possible, usually within 24 hours, and then every two weeks up to weaning at three months of age. PCV and FEC were recorded on all lambs at one and two months of age and if individual lambs had a FEC greater than 2 000 epg or a PCV less than 20% at these samplings they were treated with an anthelmintic drug. All the lambs were treated with an anthelmintic at weaning (90 days of age). They were then grazed on pasture until a monitor group of about 50 lambs, from which samples were taken every week, reached a FEC averaging about 2 000 epg. All the lambs were then weighed and faeces and blood samples were taken on two consecutive days. The lambs were then all treated with an anthelmintic. This procedure was repeated until the lambs reached a year of age, which usually involved five or six sampling times (Figure 3). No lambs were individually drenched at any of the post-weaning sampling times.

The breed effects were derived from least-squares analyses of variance (Harvey, 1990). The model fitted included, when significant, the fixed effects of year of birth, breed, sex, age of dam, lamb age as a linear covariate and any significant first-order interactions. Only single-born lambs were analysed as there were very few twin births, and most of the twin-born lambs died before weaning. Faecal egg counts were logarithm transformed ($\log_{10}$(FEC+25)) to normalise the variance and then presented in the results as the anti-log (i.e. the geometric mean-GFEC).

Heritabilities were estimated by Average Information Restricted Likelihood (AIREML) using an animal model (Johnson and Thompson, 1995). The AIREML animal model included all significant fixed effects identified in the least squares analyses and in all analyses breed-cross (six classes) and year of birth (1991-96) were included in the model. Genetic variance was partitioned into a direct additive genetic component ($h^2_a$) and the additive genetic maternal component ($h^2_m$). In addition an AIREML sire model (paternal half sib analysis) was used to estimate heritabilities ($h^2_s$). Heritabilities were also estimated using the AIREML sire model for lambs sired by Red Maasai and Dorper rams separately and in this case the breed-cross effect just included 3 classes. All breed effects and heritabilities for lambs are based on the average of the records taken on the two consecutive sampling days.

## Results

Differences among the breeds and crosses for weaning weight, PCV, GFEC and mortality for lambs at weaning and post-weaning are shown in Table 2 and Figure 4. Faecal cultures at these times showed that 66% of the larvae were *Haemonchus contortus*, 30% *Trichostronglus spp* and 4% *Oesophagostomum spp*.

The results show that Red Maasai lambs are more resistant to endoparasites than Dorpers in the subhumid zone of coastal Kenya. Red Maasai lambs have significantly lower GFEC, higher PCV and lower lamb mortality than Dorper lambs. This breed difference is already apparent in 2-month-old lambs for PCV and at weaning (3 months of age) for GFEC (Figure 4). There is also an additive genetic breed effect in the crossbred lambs for resistance (i.e. with increasing proportion of Red Maasai in the crossbred, Table 2), but no evidence for heterosis for liveweight, GFEC or PCV. The difference among breed groups in mortality is dramatic and post-mortem results show that about 50-60% of the post-weaning mortality is due to haemonchosis. The differential mortality

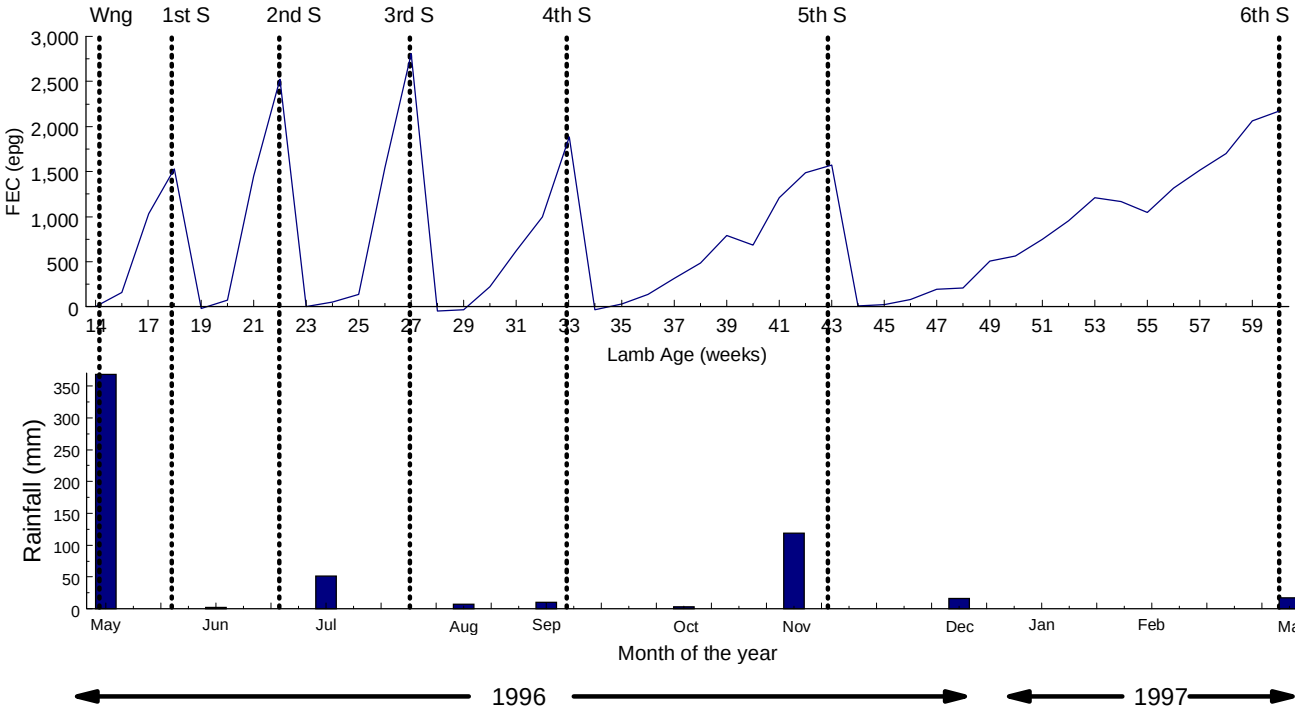



*Figure 3. Pattern of change in faecal egg count (FEC) in lambs born in 1996 and the different sampling times (S) when the threshold FEC was reached in relation to the monthly rainfall.*

conducted in the Kenya highlands (Preston and Allonby, 1978, 1979; Bain *et al*., 1993; Mugambi *et al*., 1996). In addition, Red Maasai ewes have lower FEC and higher PCV over the lambing-lactation period (the peri-parturient rise) than Dorper ewes (Baker *et al*., 1994b; 1998b).

In addition to confirming genetic variation in resistance to endoparasites among breeds and crosses, this study is providing some reliable evidence of genetic variation within these breeds (Table 3). For all live weights from birth to one year of age the additive genetic maternal heritability ($h^2_m$) was significant, while the direct additive heritability ($h^2_a$) was small and non-significant among breed-crosses also means that the least squares means for breed-cross for FEC and PCV (and possibly live weights as well) are biased. The differences among the breeds and crosses for FEC and PCV in Table 2 and Figure 4 are biased downwards because the lambs that died from haemonchosis consistently had high FEC and low PCV. The statistical solution to this problem is not a trivial issue and research is currently ongoing to attempt to resolve it by developing mixed effect nonlinear models for repeated measures employing likelihood based and Bayesian procedures.

The relative resistance of the Red Maasai lambs confirms earlier reports from research

*Table 2. Least squares means (LSM) by breed group for weaning weight (WWT, kg), packed cell volume (PCV, %), the geometric mean of faecal egg count (GFEC, eggs per gram) and mortality (MORT, %).*

| | Weaning (3 mo) | | | | Post-Weaning | | |
|---|---|---|---|---|---|---|---|
| Lamb breed[1] (Sire Bd x Dam Bd) | WWT | PCV | GFEC | MORT (Bth-Wn) | PCV (6 mo) | GFEC (6 mo) | MORT (Wn-Yg) |
| D x D | 11.2 | 23.5 | 1412 | 30.0 | 21.9 | 2818 | 39.2 |
| D x (RM x D) | 11.1 | 25.2 | 1174 | 22.4 | 21.8 | 2238 | 31.4 |
| D x RM | 10.7 | 25.7 | 1230 | 18.4 | 22.2 | 2511 | 29.8 |
| RM x D | 10.9 | 25.6 | 1023 | 20.4 | 23.5 | 2290 | 27.2 |
| RM x (RM x D) | 10.9 | 26.6 | 1096 | 16.7 | 24.0 | 2089 | 14.3 |
| RM x RM | 10.1 | 27.4 | 1174 | 10.3 | 24.3 | 1949 | 18.4 |
| Total No. | 1435 | 1411 | 1142 | 1779 | 1165 | 1165 | 1435 |
| Overall LSM | 10.8 | 25.7 | 1779 | 19.7 | 22.9 | 2291 | 26.7 |
| | | | (3.07)[3] | | | (3.36)[3] | |
| Residual S. D. | 2.2 | 5.5 | (0.56)[3] | 37.8 | 3.7 | (0.34)[3] | 38.0 |
| CV[2] (%) | 20.4 | 21.4 | 18.2[3] | 191.9 | 16.1 | 9.9[3] | 142.3 |

[1]D = Dorper, RM = Red Maasai.
[2]CV = Coefficient of variation (Residual standard deviation/LSM).
[3]*Figures in brackets are log $_{10}$(Fec+25) values which is the unit of analysis and the CV is based on these values.*

at weaning (0.05±0.04), but increased to 0.24±0.09 for YWT. The $h^2_m$ was not significant for PCV, LFEC or lamb mortality. The paternal half sib heritability estimate ($h^2_s$) for pre-weaning mortality was non-significant (0.03±0.03), but was significant for post-weaning mortality (0.10±0.05). Heritabilities (h2a and h2m) for both PCV and LFEC were small and non-significant at weaning. The $h^2_s$ for LFEC was moderate and significant in 8-month old lambs (0.18±0.08), but higher in the susceptible Dorper-sired lambs (0.35±0.16) than the resistant Red Maasai-sired lambs (0.06±0.07). This suggests that, after many centuries of natural selection under endoparasite challenge, the Red Maasai sheep have become fixed for some of the important genes for resistance. Heritabilities for live weights, PCV and mortality were also estimated separately for Red Maasai-sired lambs and Dorper-sired rams but they were not significantly different.

An assessment has been made of the flock productivity of Dorper and Red Maasai sheep in this coastal Kenyan site (Table 4). The combined effect of a higher lambing rate, lower lamb mortality and similar yearling live weights results in an approximately three-fold increase in the number of yearling sheep for sale and the weight of yearling sheep for sale in a Red Maasai *vs* a Dorper flock. There is therefore a clear economic advantage for farming the more resistant breed in the coastal Kenya sub-humid environment. These findings have resulted in FAO funding the development of a pilot nucleus breeding scheme for Red Maasai sheep in coastal Kenya. The ultimate aim of this breeding scheme is to make Red Maasai rams more readily available to smallholder farmers in the coastal region of Kenya.

## Kenya – Goats

The Galla and the Small East African (SEA) goats breeds (Figures 5 and 6) are also being evaluated for their resistance to endoparasites at Diani Estate using the same experimental protocol as for the sheep. In this case the

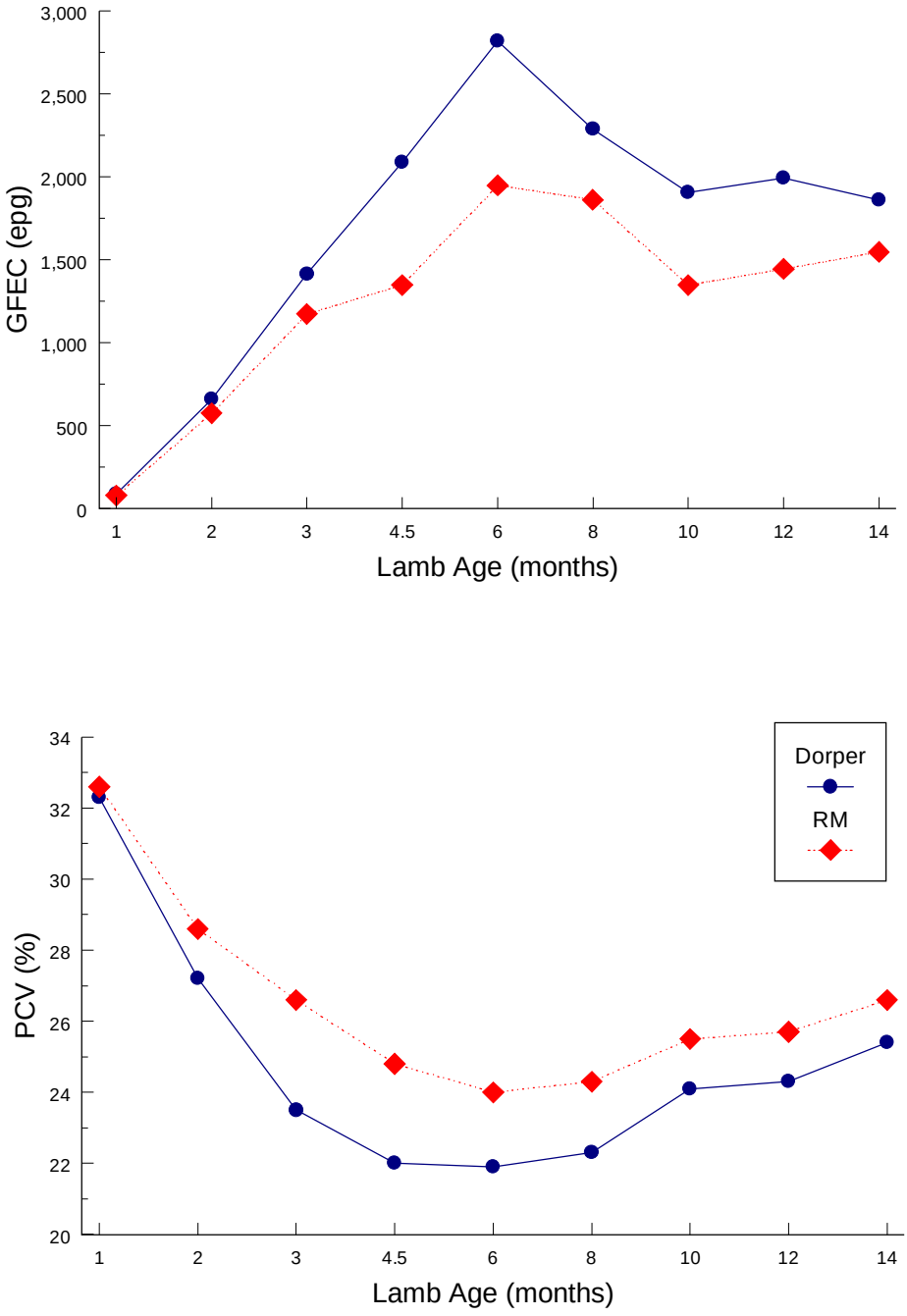



*Figure 4. The geometric mean of faecal egg count (GFEC) and packed cell volume (PCV) for Red Maasai and Dorper lambs from 1 to 14 months of age.*

*Table 3. Heritability estimates for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), packed cell volume (PCV), logarithm transformed faecal egg count (LFEC) and lamb mortality.*

| Trait | No. records | Animal model[1] No. dams | No. sires | $h^2_a \pm se$ | $h^2_m \pm se$ | Sire model $h^2_s \pm se$ |
|---|---|---|---|---|---|---|
| BWT | 1 792 | 724 | 76 | 0.10±.04 | 0.37±.03 | 0.10±.04 |
| WWT | 1 435 | 659 | 76 | 0.05±.04 | 0.28±.04 | 0.03±.04 |
| YWT | 970 | 530 | 75 | 0.24±.09 | 0.18±.05 | 0.24±.09 |
| PCV-Wng | 1 411 | 652 | 76 | 0.01±.03 | 0.05±.03 | 0.01±.03 |
| PCV- 8mo | 1 080 | 558 | 75 | 0.07±.06 | 0.02±.04 | 0.08±.06 |
| LFEC-Wng | 1 142 | 591 | 76 | 0.01±.04 | 0.00±.04 | 0.04±.05 |
| LFEC- 8mo | 1 080 | 558 | 75 | 0.10±.06 | 0.00±.04 | 0.18±.08 |
| Lamb mortality | | | | | | |
| Bth-Wng | 1 779 | 720 | 76 | 0.02±.03 | 0.04±.03 | 0.03±.03 |
| Wng-Ylg | 1 437 | 659 | 76 | 0.09±.05 | 0.00±.03 | 0.10±.05 |

[1]$h^2_a$ = additive direct heritability; $h^2_m$ = additive maternal heritability.

*Table 4. Productivity of flocks of Dorper and Red Maasai sheep and Galla and Small East African (S.E.A.) goats at Diani Estate, Mombasa, Kenya.*

| Trait | Dorper | Red Maasai | Galla | S.E.A |
|---|---|---|---|---|
| No. of ewes/does mated | 853 | 457 | 371 | 359 |
| Ewe/doe live weight (kg) | 30 | 26 | 35 | 28 |
| Ewes lambing/ewes mated (%) | 66.4 | 75.1 | 47.4 | 75.2 |
| Prolificacy (%) (lambs born/ewes lambing) | 102.0 | 101.9 | 116.5 | 129.3 |
| Lamb/Kid mortality (Bth-Ylng, %) | 66 | 28 | 45 | 35 |
| Yearling live weight (kg) | 19.7 | 18.4 | 18.5 | 15.5 |
| **Offtake (1 yr)[1]** | | | | |
| No. of sheep/goats | 11 | 35 | 15 | 43 |
| Total live weight (kg) | 217 | 644 | 278 | 667 |

[1]Offtake based on a 100 ewe or doe flock with a 20% female replacement rate and all male progeny and non-replacement females alive at one year of age making up the offtake. The Dorper and Galla flocks are not sustainable at this replacement rate in this environment.

*Figure 5. Small East African goats.*

*Figure 6. Galla goats.*

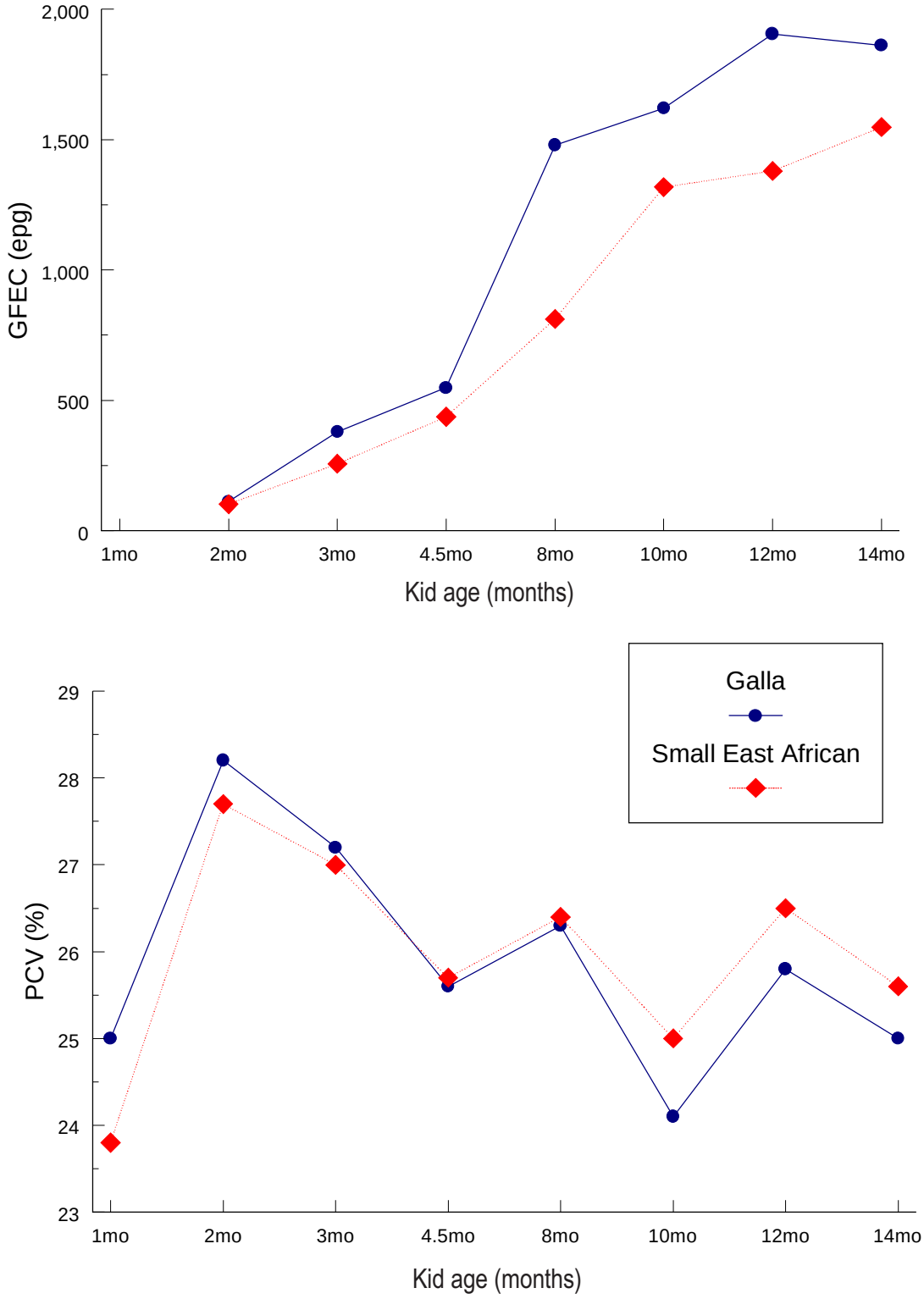



*Figure 7. The geometric mean of faecal egg count (GFEC) and packed cell volume (PCV) for Galla and Small East African kids from 1 to 14 months of age.*

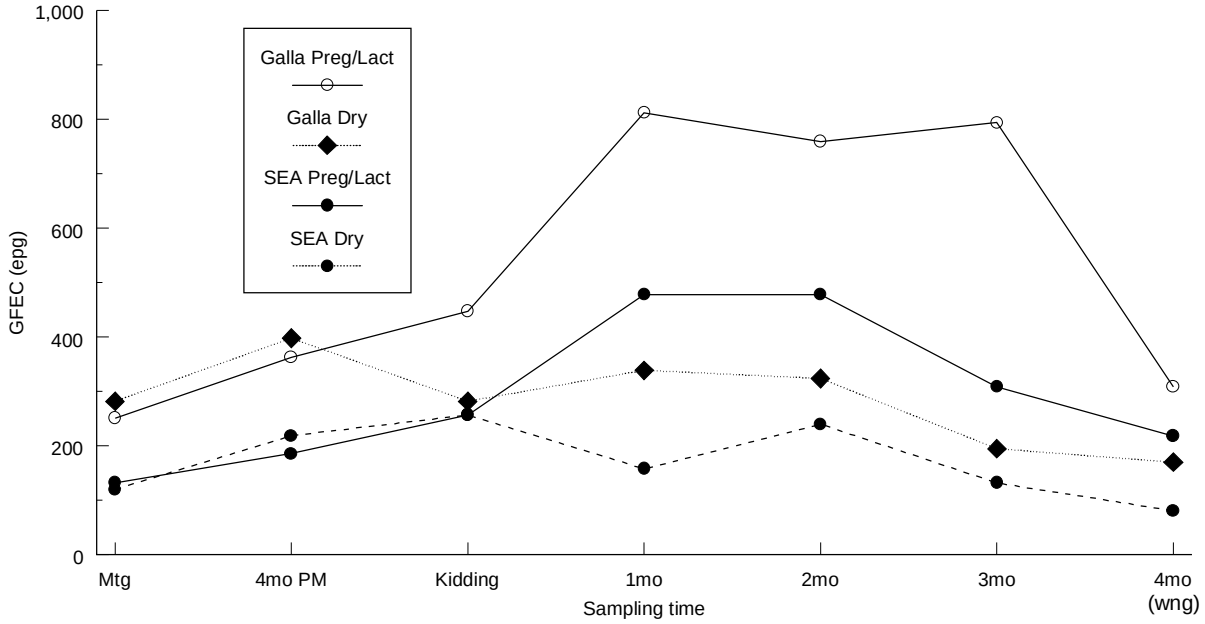



*Figure 8. The geometric mean of faecal egg count (GFEC) for pregnant/lactating and dry (non-pregnant) Galla and Small East African (SEA) does.*

experimental design is a comparison of the two breeds and not a diallel design as for the sheep experiment. Five crops of kids were produced between 1992 and 1996 and a total of 553 kids were born (204 Galla and 349 SEA). These were the progeny of 18 Galla and 17 SEA bucks. The statistical analyses were similar to those for the sheep except now litter size was included in the model as a fixed effect.

The SEA kids are more resistant to GI nematode parasites than Galla kids as shown by lower FEC in SEA kids post-weaning and a significantly higher PCV in SEA kids. The higher PCV in the resistant SEA kids occurs when they are 10-12 months of age (Figure 7), which is a different response than that observed in the lambs where the breed difference in PCV is apparent by 2 months of age. The breed difference in kid mortality is not as dramatic as in the lambs, but the resistant SEA kids had a significantly lower mortality from birth to one year of age than the Galla kids (35.4% *vs* 44.6%, respectively). The breed difference in resistance was also apparent in the does (Baker *et al.,* 1998a) and the difference in FEC was particularly marked in pregnant/lactating does over the peri-parturient period (Figure 8). These results are consistent with those reported by Shavulimo *et al*. (1988) but not consistent with those reported in a small study by Preston and Allonby (1978) where Saanen goats were more resistant than Galla and SEA goats.

This goat data set is not large enough to allow reliable heritabilities to be estimated. The heritabilities ($h^2_a$) of PCV and FEC at weaning were 0.11±0.11 and 0.11±0.10, respectively. Utilising the first three post weaning measurements in repeated measures analyses, the heritabilities ($h^2_a$) for 6-month old kids were 0.18±0.06 for PCV and 0.03±0.03 for FEC.

There is a marked difference in reproductive performance between these two breeds with overall reproduction (kids weaned/does mated) being 79% for SEA and 40% for the Galla. This results in a clear advantage in flock productivity for the SEA *vs* the Galla (Table 4). It is also interesting to note that the productivity, measured by weight of lambs or kids available for sale, of the resistant Red Maasai sheep and the resistant SEA goats were very similar in this environment (644 kg *vs* 667 kg, respectively).

## Future Plans

The first phase of this research project involving quantifying between- and within-breed genetic resistance of some indigenous breeds of sheep and goats in sub-Saharan Africa is now nearing completion. Similar characterisation research will be carried out in other tropical regions of the world. For example, new research in Southeast Asia (initially in the Philippines and Indonesia) will begin in 1999.

The second phase of this study (1998-2002) will investigate parasitological, immunological and genetic mechanisms of resistance; develop and test sustainable, integrated endoparasite control strategies; identify genetic (DNA) markers for resistance; and develop breeding strategies for resistance to endoparasites in tropical environments. Research has begun in Kenya using $F_1$ rams from resistant and susceptible breeds (i.e. Red Maasai x Dorper) to produce large double backcross resource families to search for markers and ultimately genes controlling resistance to GI nematode parasites (particularly *Haemonchus contortus*).

# Acknowledgements

The results from the ILRI research project on genetic resistance to endoparasites in small ruminants which are briefly summarised here depended on the collaborative efforts of many people. I would like to acknowledge in particular W. Thorpe, J.O. Audho, E. Aduda (ILRI, Nairobi, Kenya), D. M. Mwamachi (Kenya Agricultural Research Institute) and R. Haller (Baobab Farm, Mombasa, Kenya). This is ILRI Publication No. 98027.

# References

**Albers, G.A.A., Gray, G.D., Piper, L.R., Barker, J.S.F., Le Jambre, L.F. & Barger, L.A.** 1987. The genetics of resistance and resilience to *Haemonchus contortus* infection in young Merino sheep. International Journal for Parasitology 17: 1355-1363.

**Bain, R.K., Wanyangu, S.W., Mugambi, J.M., Ihiga, M.A., Duncan, J.L. & Stear, M.J.** 1993. Genetic resistance of Red Maasai sheep to *Haemonchus contortus*. Proceedings of the 11th Scientific Workshop of the Small Ruminant Collaborative Research Support Program (SR-CRSP), March 1993, Nairobi, Kenya, 120-126.

**Baker, R.L.** 1995. Genetics of disease resistance in small ruminants in Africa. In: G.D. Gray, R.R. Woolaston & B.T. Eaton (Eds), Breeding for Resistance to Infectious Diseases of Small Ruminants, ACIAR Monograph No 34, Canberra, Australia, 120-138.

**Baker, R.L., Lahlou Kassi, A., Rege, J.E.O., Reynolds, L., Bekele, T., Mukassa-Mugerwa, E. & Rey, B.** 1992. A review of genetic resistance to endoparasites in small ruminants and an outline of ILCA's research programme in this area. Proceedings of the 10th Scientific Workshop of the Small Ruminant Collaborative Research Support Program, Nairobi, Kenya, 79-104.

**Baker, R.L., Mwamachi, D.M., Audho, J.O. & Thorpe, W.** 1994a. Genetic resistance to gastrointestinal nematode parasites in Red Maasai sheep in Kenya. Proceedings of the 5th World Congress on Genetics Applied to Livestock Production, 7-12 August, 1994, Guelph, Canada, 20: 277-280.

**Baker, R.L., Mwamachi, D.M., Audho, J.O. & Thorpe, W.** 1994b. Genetic resistance to gastrointestinal parasites in Red Maasai, Dorper and Red Maasai x Dorper ewes in coastal Kenya. Proceedings of the 12th SR-CRSP Scientific Workshop, March, 1994, Nairobi, Kenya, 100-109.

**Baker, R.L., Mwamachi, D.M., Audho, J.O., Aduda, E.O. & Thorpe, W.** 1998a. Resistance of Galla and Small East African goats in the sub-humid tropics to gastrointestinal nematode infections and the peri-parturient rise in faecal egg counts. Veterinary Parasitology (in press).

**Baker, R.L., Rege, J.E.O., Tembely, S., Mukasa-Mugerwa, E., Anindo, D., Mwamachi, D.M., Thorpe, W. & Lahlou-Kassi, A.** 1998b. Genetic resistance to gastrointestinal nematode parasites in some indigenous breeds of sheep and goats in East Africa. Proceedings of the 6th World Congress on Genetics Applied to Livestock Production, Armidale, Australia, 25:269-272.

**Barger, I.A. & Sutherst, R.W.** 1991. Population biology of host and parasite. In: G.D. Gray & R.R. Woolaston (Eds) Breeding for Disease Resistance in Sheep, Australian Wool Corporation, Melbourne, Australia, 51-56.

**Bisset, S.A. & Morris, C.A.** 1996. Feasibility and implications of breeding sheep for resilience to nematode challenge. International Journal for Parasitology, 26: 857-868.

**Bisset, S.A., Morris, C.A., Squire, D.R., Hickey, S.M. & Wheeler, M.** 1994. Genetics of resilience to nematode parasites in Romney sheep. New Zealand Journal of Agricultural Research, 37: 521-534.

**Bouix, J., Vu Tun Khang, J., Mandonnet, N. & Gruner, L.** 1995. Response to artificial infections with *Teladorsagia circumcincta* in sheep bred for resistance to natural infections. International Conference on Novel Approaches to the Control of Helminth Parasites of Livestock, University of New England, Armidale, N.S.W., Australia, 18-21 April, 1995, Abstract Booklet, 33.

**Boyce, W.M., Courtney, C.H. & Loggins, P.E.** 1987. Resistance to experimental infection with *Fasciola hepatica* in exotic and domestic breeds of sheep. International Journal for Parasitology, 17: 1233-1237.

**Bradford, G.E. & Fitzhugh, H.A.** 1983. In: H.A. Fitzhugh & G.E. Bradford (Eds), Hair sheep of Western Africa and the Americas. A Genetic Resource for the Tropics, Westview Press, Boulder, Colorado, USA, 3-22.

**Clunies-Ross, I.** 1932. Observations on the resistance of sheep to infestation by the stomach worm, *Haemonchus contortus*. Journal of the Council for Scientific and Industrial Research, 5: 73-80.

**Dargie, J.D.** 1982. The influence of genetic factors on the resistance of ruminants to gastro-intestinal nematode and trypanosome infections. In: D.G. Owen (Ed.), Animal Models in Parasitology, McMillan Press Ltd, London, U.K., 17-51.

**Douch, P.G.C., Green, R.S., Morris, C.A., McEwan, C.A. & Windon, R.G.** 1996. Phenotypic markers for selection of nematode resistant sheep. International Journal for Parasitology, 26: 899-911.

**Eady, S.J.** 1995. Phenotypic traits associated with resistance to internal parasites. In: G.D. Gray, R.R. Woolaston and B.T. Eaton (Eds), Breeding for Resistance to Infectious Diseases of Small Ruminants, ACIAR Monograph No. 34, Canberra, Australia, 219-236.

**Fabiyi, J.P.** 1987. Production losses and control of helminths in ruminants of tropical regions. International Journal for Parasitology, 17: 435-442.

**Gray, G.D.** 1991. Breeding for resistance to Trichostrongyle nematodes in sheep. In: J.B. Owen & R.F.E. Axford (Eds), Breeding for Disease Resistance in Farm Animals, CAB International, Wallingford, U.K., 139-161.

**Gray, G.D. and Woolaston, R.R.** 1991. Breeding for Disease Resistance in Sheep. Wool Research and Development Corporation, Melbourne, Australia, pp. 151.

**Gray, G.D., Gill, H.S. & Woolaston, R.R.** 1991. Relationships among sheep diseases of commercial importance. In: G.D. Gray & R.R. Woolaston (Eds) Breeding for Disease Resistance in Sheep, Wool Research and Development Corporation, Melbourne, Australia, 57-65.

**Gray, G.D., Woolaston, R.R. & Eaton, B.T.** 1995. Breeding for Resistance to Infectious Diseases of Small Ruminants. Australian Centre for International Agricultural Research (ACIAR) Monograph No. 34, Canberra, Australia, pp. 322.

**Gray, G.D., Presson, B.L. , Albers, G.A.A., Le Jambre L.F., Piper, L.R. & Barker J.S.F.** 1987. Comparison of within - and between-breed variation in resistance to haemonchosis in sheep. In: B.J. McGuirk (Ed.), Merino Improvement Programs in Australia, Australian Wool Corporation, 365-369.

**Gruner, L**. 1991. Breeding for helminth resistance in sheep and goats. In: R.F.E. Axford & J.B. Owen (Eds) Breeding for Disease Resistance in Farm Animals, CAB International, Wallingford, U.K., 187-200.

**Hansen, J. & Perry, B.** 1994. The Epidemiology, Diagnosis and Control of Helminth Parasites of Ruminants. Second edition, ILRAD, Nairobi, Kenya, pp. 171.

**Harvey, W.R.** 1990. Users guide for the PC-2 version of the LSMLMW and MIXMDL mixed model least squares and maximum likelihood computer program, Ohio State University, Columbus, USA.

**ILCA (International Livestock Centre for Africa).** 1991. Proceedings of the Research Planning Workshop on Resistance to Endoparasites in Small Ruminants. 5-7 February 1991, ILCA, Addis Ababa, Ethiopia, pp. 78.

**Johnson, D.L. & Thompson, R.** 1995. Restricted Maximum Likelihood estimation of variance components for univariate animal models using sparse matrix techniques and average information. Journal of Dairy Science 78: 449-456.

**McKenna, P.B.** 1981. The diagnostic value and interpretation of faecal egg counts in sheep. New Zealand Veterinary Journal 29: 129-132.

**Morris, C.A., Watson, T.G., Bisset, S.A., Vlassoff, A. & Douch, P.G.C.** 1995. Breeding sheep in New Zealand for resistance or resilience to nematode parasites. In: G.D. Gray, R.R. Woolaston & B.T. Eaton (Eds), Breeding for Resistance to Infectious Diseases of Small Ruminants, ACIAR Monograph No.34, Canberra, Australia, 77-98.

**Mugambi, J.M., Wanyangu, S.W., Bain, R.K., Owango, M.O., Duncan, J.L. & Stear, M.J.** 1996. Response of Dorper and Red Maasai lambs to trickle *Haemonchus contortus* infections. Research in Veterinary Science, 61: 218-221.

**Osinowo, O.A. & Abubakar, B.Y.** 1988. Appropriate breeding strategies for small ruminant production in West and Central Africa. In: K.O. Adeniji (Ed), Proceedings of the Workshop on the Improvement of Small Ruminants in West and Central Africa, OAU/IBAR, Nairobi, Kenya, 71-84.

**Owen, J.B. & Axford, R.F.E.** 1991. Breeding for Disease Resistance in Farm Animals. CAB International, Wallingford, United Kingdom, pp. 499.

**Piper, L.R. & Barger, I.A**. 1988. Resistance to gastrointestinal strongyles: feasibility of a breeding programme. In: Proceedings of the 3rd World Congress on Sheep and Beef Cattle Breeding, Paris, France, Vol. 1: 593-611.

**Preston, J.M. & Allonby, E.W.** 1978. The influence of breed on the susceptibility of sheep and goats to a single experimental infection with *Haemonchus contortus*. Veterinary Record, 103: 509-512.

**Preston, J.M. & Allonby, E.W.** 1979. The influence of breed on the susceptibility of sheep to *Haemonchus contortus*. Research in Veterinary Science, 26: 134-139.

**Roberts, J.A., Estuningsih, E., Widjayanti, S., Wiedosari, E., Partoutomo, S. & Spithill, T.W.** 1997a. Resistance of Indonesian Thin Tail sheep against *Fasciola gigantica* and *F. hepatica.* Veterinary Parasitology, 68: 69-78.

**Roberts, J.A., Widjayanti, S., Estuningsih, E. & Hetzel, D.J.S.** 1997b. Evidence for a major gene determining the resistance of Indonesian Thin Tail sheep against *Fasciola gigantica*. Veterinary Parasitology, 68: 309-314.

**Shavulimo, R.S., Rurangirwa, F., Ruvuna, F., James, A.D., Ellis, P.R. & McGuire, T.** 1988. Genetic resistance to gastrointestinal nematodes, with special reference to *Haemonchus contortus*, in three breeds of goats in Kenya. Bulletin of Animal Health and Production in Africa, 36: 233-241.

**Smith, O.B.** 1988. Health packages for the small-holder farmers in West and Central Africa. In: K.O. Adeneji (Ed.) Proceedings of the Workshop on the Improvement of Small Ruminants in West and Central Africa, OAU/IBAR, Nairobi, Kenya, 211-221.

**Waller, P.J.** 1997. Anthelmintic resistance. Veterinary Parasitology, 72: 391-412.

**Wiedosari, E. & Copeman, D.B.** 1990. High resistance to experimental infection with *Fasciola gigantica* in Javanese thin tail sheep. Veterinary Parasitology, 37: 101-111.

**Windon, R.G.** 1990. Selective breeding for the control of nematodiasis in sheep. Reviews Scientifiques et Technicales de l'Office internationale de Epizooties, 2: 555-576.

**Windon, R.G.** 1991. Resistance mechanisms in the *Trichostrongylus* selection flock. In: G.D. Gray & R.R. Woolaston (Eds) Breeding for Disease Resistance in Sheep, Australian Wool Corporation, Melbourne, 77-86.

**Woolaston, R.R.** 1997. Detecting genetic differences among groups of sheep during parasite infection. International Journal for Parasitology, 27: 839-841.

**Woolaston, R.R. & Baker, R.L.** 1996. Prospects of breeding small ruminants for resistance to internal parasites. International Journal for Parasitology, 26: 845-855.

**Woolaston, R.R. & Eady, S.J.** 1995. Australian research into genetic resistance to nematode parasites. In: G.D. Gray, R.R. Woolaston & B.T. Eaton (Eds), Breeding for Resistance to Infectious Diseases of Small Ruminants, ACIAR Monograph No. 34, Canberra, Australia, 53-76.

**Woolaston, R.R., Elwin, R.L. & Barger, I.A.** 1992. No adaptation of *Haemonchus contortus* to genetically resistant sheep. International Journal for Parasitology, 22: 377-380.

**Woolaston, R.R., Windon, R.G. & Gray, G.D.** 1991. Genetic variation in resistance to internal parasites in the Armidale experimental flocks. In: G.D. Gray & R.R. Woolaston (Eds) Breeding for Disease Resistance in Sheep, Australian Wool Corporation, Melbourne, 1-9.

# The Ponies of the Giara highland

***M. Dattilo***

*Centre for Phenomenological Studies, Dept. of Animal Production, University of Sassari*
*Piazza Conte di Moriana s.n.c., 07100* ***Sassari****, Italy*

## Summary

The Giara pony is a less known, equine breed of small stature, typical of the island of Sardinia. It draws its denomination from the highland of the Giara, where it lives in the wild.

The ponies appeared in Sardinia approximately in the VII century B. C. Recent research, carried out on haemoglobin polymorphism, underlined some analogies with the Arabic horses of North-Africa.

These ponies, have a dolyichomorphic-type constitution with long, naked and resistant legs. In the past they were used for agricultural work, however later, with the increase of mechanisation, they returned to the Giara highland where they became feral.

The Giara ponies, in the light of recent scientific research, possess not only an inestimable genetic patrimony but they also represent a large source of interest for the equestrian sport, and, above all, for children's riding therapy.

The author underlines, finally, that the principal material of this article has been outlined in a symposium held at the University of Sassari 18/11/1997, entitled: "Phenomenology of the environment: psycho-social and zoo-anthropological perspectives".

## Resumen

El poco conocido pony Giara pertenece a una raza equina de pequeña estatura, típica de la isla de Cerdeña. Su nombre le viene del altiplano de Giara donde vive en estado silvestre.

Los ponys aparecen en Cerdeña aproximadamente en el siglo VII a.C. Investigaciones recientes llevadas a cabo sobre el polimorfismo en la hemoglobina, indican algunas semejanzas con el caballo Arabe de Africa del Norte.

Estos ponys tienen una constitución dolicomórfica con cuello largo y patas resistentes. En el pasado se utilizaban para el trabajo de campo, sin embargo más tarde, con el aumento de la mecanización, volvieron a la zona del altiplano de Giara donde se volvieron de nuevos silvestres.

Los ponys Giara, a la luz de recientes investigaciones científicas, poseen no sólo un patrimonio genético inestimable, sino que también representan una fuente importante de recursos para el deporte ecuestre y, sobre todo, para la terapia infantil.

El autor subraya que los temas principales de este artículo han sido ilustrados en un symposium que tuvo lugar en la universidad de Sassari el 18 de noviembre 1997, bajo el título: Fenomenología del medio: prospectivas psicosociales y zooantropológicas.

***Key words****: Riding therapy, Horse psychology, Sardinia, Characteristics.*

## Introduction

The ponies live in the wild on the Giara plateau. The Giara is a basaltic plateau of coarsely triangular form in the Southern-Centre of Sardinia (between the Marmilla and the Sarcidano), approximately

42 km² and 550 m above sea level (Figure 1). It occupies around 4 600 hectares, half of which really are the highland, the other half being a small, undulated and characteristically rural area around the highland itself (Genoni, Gesturi, Tuili, etc.). The unemployment level is very high and constitutes about 25% of the active population.

The word Giara (*Yara* in Sardinian) derives from the Latin *Glarea*, that means gravel. It can be recognised by two cone-shaped reliefs, that are what remains of two volcanoes that were erupting until two million years ago; pouring out the lava that today constitutes the basaltic matrix of the ground. There are natural basins called *Paulise*, which collect rain water however the water cannot flow out and in drought periods, water is lacking and the ponies suffer terribly from thirst.

The agricultural land, based on volcanic (basaltic) rocks rich in Ca, Mg, Fe, highly diffused in Sardinia, is present almost everywhere with its black colour, shallow depth and scarce fertility. In the past, the tall stem plants (cork oak, ilex, wild olive tree, etc.), were predominant but subsequently they have been partially replaced (because of human impact and fires) by shrub species (*Cistaceae, Arbutus unedo, Myrtus communis*, etc.; wild orchids in spring). The pasture, naturally scarce, is exploited by the other domestic animals and it is not abundant enough to feed the ponies. However, the ponies hoofs are sufficiently elastic and adjust well, allowing the ponies an extraordinary ability of movement and resistance in a unstony dry ground . The distinctive environment of the Giara horses is shown in figure 2.

## Pony Breeds

In the dreams of every child there is always a pony upon which to gallop and challenge danger. Such dreams do not often come true. The pony is a horse of small stature that does not exceed 140-145 cm height at withers.

There are different pony clubs which allow children to sit in the saddle from a tender age. Currently in Italy there are hundreds of pony clubs, present in almost all the regions, the island of Sardinia included.

Children not only learn to ride with the pony, but they establish a psychological relationship and are stimulated to love animals. Many Italian riders who represent Italy in the international competitions, learnt to ride first on ponies when they were

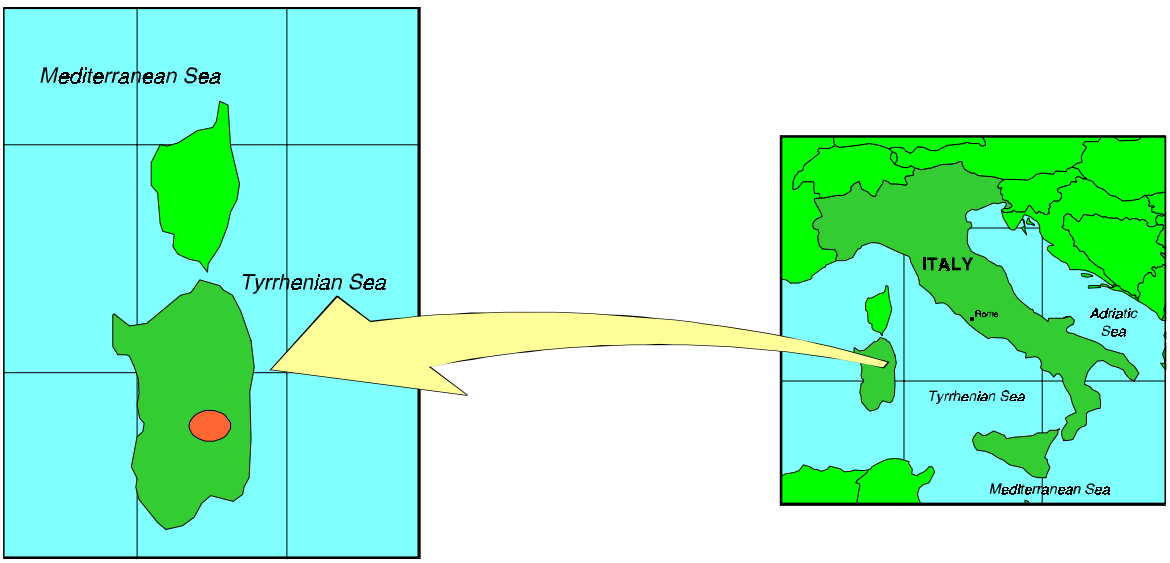



*Figure 1. Geographic position of Sardinia and Giara higland (in circle) in respect to Italy.*

children. The demand for ponies from individuals is constantly increasing. Ponies are generally imported to Italy from England, Ireland and France, at an average price of 3-4 millions liras (about 2 000-3 000 dollars) per head. The training with the ponies for children starts like playing with a new friend. The group games develop sociality, according to the witticism "one for all and all for one". An example of these group games is the sack race (one partner riding and the other bouncing in the sack and holding the pony by the reins) or the slalom competition between cans or stakes, etc. The children not only learn to enjoy themselves but, above all, to respect the animals; a school of sport is a school of behaviour, where self-control and steadiness of mind are emphasised.

The children's love for the ponies is something, I would say, innate, which has existed for a long time. A relationship of comprehension and friendship is established between the child and the foal. The pony for its particular efficiency of the nervous system (10-12 times more rapid than that of man) can face an obstacle, an impediment, with greater safety and awareness than that of its rider; and the child adapts to such a condition and becomes more confident. Horseback riding is one of the most formative schools and most socialising activity for children. In the Sardinian population, love for horses has existed for a long time; from this ancient love stems the great importance of saving the future of the Ponies of the Giara, source of wealth and testimony of the Sardinian tradition. In the figurative sense, facing the obstacle also means facing the problems of life and trying to resolve them. In a lot of human situations, incapability to take an immediate decision when faced with a problem, involves serious psychic consequences and forms of depression.

*Figure 2. Giara horses in their natural environment.*

F*igure 3. Chestnut mare (From Studfarm of Dr. A. Tatti).*

In many pony clubs the psychology of the horse is also considered in the teaching programmes. For example, in Turin the Pony Club sends its founders to the primary and secondary schools to give lessons in the classroom with films and slides, etc. and to offer free invitations to visit to the club and to attend the first classes.

There are currently different breeds of pony in the world; in Europe the most well known are:

- Pony-Great Britain (Country of Wales) 1.22-1.27 cm height;
- Dartmoor Pony, (County of Devon), they also reach the height of 1.40 cm because they have been crossed with English pure-breds;
- Irish pony (County of Galway) of Irish origin not modified over the centuries (1.32-1.42 m height); and
- Shetland Pony (Shetland Islands, off coast of Scotland ); 0.80-100 cm average height.

The latter, isolated in the numerous islands of the archipelago, had to adapt to the environment characterised mainly by cold seasons and shortage of forage. For this reason they have been selected for their small form, more compactness, rusticity and thick hair to withstand the cold. They are also at risk of disappearing because of man's use of them under difficult conditions in the mines as pit ponies.

The ponies of the Shetland Islands were famous, instead, for their high economic interest and they are requested for their small stature and notable spirit of adaptation and docility.

There are still different families of pony: Norwegians; Corsican deriving from the mountainous regions of Corsica where they still live in the wild and are used for saddling and for small jobs (height 1.30-1.40 m); Pony of the Moors (France) of Arabic origin, which became small because of the poor soil (height

1.35 m maximum). Besides, there are also the Icelandic pony similar to the Shetland, and the ponies from Spain and Portugal. The Giara ponies, of which few characteristics are known abroad, can be classified among the latter type of ponies. Their origin was lost a long time ago, however good testimonies regarding the existence of the ponies in Sardinia can be approximately dated to the VII century B. C.

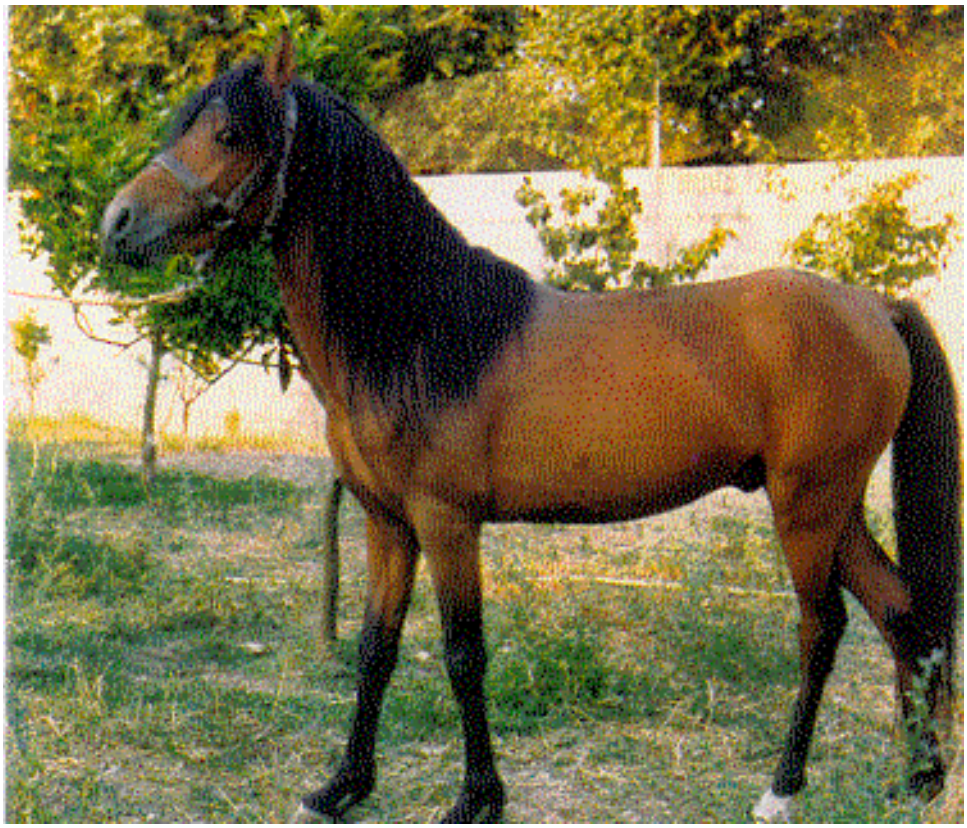
Recently, research on the haemoglobin polymorphism , (Manca L.), has shown some analogies (frequency of rare haplo-types) with the Arabic horses from North-Africa.

Besides, research carried out in Sardinia to ascertain the presence of specific antibodies in blood serum for various disease has shown similar conditions to the other horses of Sardinia. Their absolute negativity for the flu disease was remarkable.

There are no differences in the number of the chromosome (64) compared with other horses; therefore they are not wild horses but must be considered as horses which have returned to their wild state.

It is clear that these equines were at first used by the local populations for country work, mainly the threshing of wheat by treading. Subsequently, when their use lost economic interest, the Giara ponies, sheltered in the Giara highland, underwent a natural selection through which they have been selected for rusticity, smaller body and higher resistance. This was also verified in Corsica and, moreover in the famous Shetland Islands, where the smallest animals can be found.

The conformation of the Giara pony is different from that of the Shetland Islands. The latter breed has a brachyimorphic-type constitution, that resembles a miniature heavy draught horse; while the Giara ponies have kept their dolychomorphic appearance. It is estimated that at present in the highlands of the Giara there are approximately 600 head, naturally divided in herds. Figures 3, 4 and 5 show a chestnut mare, a



F*igure 4. Bay stallion (From Studfarm of Dr. A. Tatti).*

bay stallion and a mare with suckling colt, respectively.

Some of the most interesting characteristics that the foals exhibit according to natural variability, are the following:

- Constitution: meso-dolyichomorphic;
- Hair coat: bay, black, chestnut, clear mantles;
- Height at withers: 128-132cm;
- Live weight: 170-220 kg;
- Head: adorned by abundant forelock, often long;
- Neck: strong, wide at chest, thick mane;
- Trunk: long with light back-lumbar depression;
- Legs: prolonged with good muscular structure, equipped with long and resistant shin; small hoofs, resistant to rough ground;
- Other characteristics: vivacity, safety and agility; notable frugality; curiosity towards people and good attitude to domestication.

Finally, it is necessary to add that it would be a serious error to cross these equines with other breeds to increase their stature. In the past such crosses have been made to increase meat production. If conservation efforts succeed in preserving the breed at its present stature, the Giara pony could result in a notable economic resource for Sardinia.

## Psychology

The relationship between horse and man has intrigued thinkers since ancient times. Cicero, Plinio; and more recently Buffon, Lamark, Darwin, etc. must be remembered.

In France, one important Museum of the Horse in Saumur was created (in the area near Nantes-Orleans) that, among other purposes, has the aim of stimulating the curiosity of the visitors and the interest of the researchers in the knowledge of the animal psyche and the principal affective stages.

## Main Affective Stages

- *Language:* expressed by attitudes, and sometimes accompanied by neighs of particular intensity, recognisable by the keeper; from the physiognomy with facial

*Figure 5. Mare with suckling colt*

F*igure 6. Children at their first experience with Giara pony.*

mimicry; from the gait of the head, from the movement of the ears and the lips, etc.

- *Fear:* sense of uncertainty and restlessness , that can degenerate, in situations of imminent danger, into reactions of dismay (almost madness) or of escape or of paralysis, provoked from the supreme instinct of survival; in such cases they produce physiological effects similar to that of man: cardiac acceleration, cooling of the body; tremor; erection of the hair and release of the sphincters.
- *Joy and sadness:* release and escape of the young foals when they go into the open air and into the fields; the mother's recognition after a long absence; contrarily, in case of sadness, low head, abandonment, weariness.
- *Anger:* occurs especially in stallions, during the mating period, when they become impatient and can bite and kick.
- *Revenge:* vengeful instinct toward those who maltreat them. Their memory is indelible.

## Genetic Aspects

It is important to underline that losing a breed means the disappearance of a genetic patrimony of an incalculable value which cannot be rebuilt. If we consider that the genes can be thought universal, (they can be transferred from a nucleus of a cell to another one of the living world, without distinction among plants, animals and, in theory, human kind) their peculiar relevance is also evident in the future, with the advances of genetic engineering.

Actually we do not know the chromosomal map of the ponies of the Giara and very little is known about their specific genes. The knowledge on the action of such genes could help in understanding some illnesses and hereditary imperfections , particularly on the defence of the cellular membranes, and on the impediment of the formation of free radicals.

## Conclusions

In these last years the initiatives to save the foals of the Giara have assumed an increasing incisiveness. In 1976 the Breeders Association of the Sardinian Pony of the Giara was constituted with legal centre in Genoni. In 1991 the Institute for the Horse Improvement received in concession from the Monte Pascoli Regionali (Regional Mountain Pasture) the farm "Lavra" comprehensive of approximately 684 hectares in the highland. The farm has been fenced and numerous ponies have already been acquired in conformity with the requisite of the breed.

Besides, the decree of 27/07/90 promulgated by the Minister of Agriculture established the Register of the Equine Populations, referable to local ethnic groups. The Italian Breeders Association established the formalities of the register of breed (foals and fillies, breeding mare registry; stallion registry) and substituted the old tagging system by the insertion of a microchip in the left side of the neck. The University of Sassari, with the invaluable help of the Faculty of Veterinary Medicine, introduced an essential contribution for health, survival and better knowledge of the ponies of the Giara.

Currently, the mayors of 12 villages involved in this topic, the presidents of three Mountain Communities and the three Chairmen to the environment of Nuoro, Oristano and Cagliari have established an agreement to create the Park of the Giara.

The initiatives, summarisedabove, show that the public, the technical community and the politicians have become aware of and involved in the issue of the safeguard of the ponies of the Giara. However, to help sustain the breed on economic basis, it is important to make people aware of the role of the breed and to set up a medical-sporting centre for children.

The fundamental objectives of the Centre can be summarised in the following way:

- To allow the children, in the most suitable seasons, a period of rest and sport during which they can learn to love the foals and to learn the equestrian sport (Figure 6);
- To allow disabled children (autistic etc.)[1] to frequent the suitable medical centre for their health and to recover, close to the foals, courage, interest in life, and mitigate their illness by improving the clinical picture with a notable recovery toward normality.

Close to these two fundamental parameters (the care and the health of the child) important tourist returns are appearing. This offers the possibility, not only of lodging in the different villages those tourists who come in search of uncontaminated environments and horseback riding, but also to provide horse-riding and trekking and acquaint them with the beauty and the nature of the Giara.

## References

**Ballarini, G.** 1998. Umanesimo ed animalismo, Fondazione iniziative zooprofilattiche e zootecniche, Brescia, Italy.

**Centro Studi Fenomenologici dell'Università di Sassari**. 1997. Conferenza-Dibattito: Fenomenologia dell'ambiente. Prospettive zoo-antropologiche e psicosociali. Sassari, Italy.

**Dattilo, M.** 1991. Costituzione e nutrizione del cavallo, Edagricole, Bologna, Italy.

**Enna, G.** 1997. La ragazza della Giara, Edizioni Dattena, Cagliari, Italy.

**Istituto Incremento Ippico della Sardegna**. 1992. Inseminazione strumentale nella specie equina, Atti 1° Convegno Internazionale, Litotipografia Pisano, Cagliari, Italy.

[1] Autistic is the psychic attitude by which the subject lives closed in on itself, detached from the sense of reality. Subjects have a tendency to isolation and to close in on himself in an internal dream-life. Autism can be a prelude to psychic illnesses.

**Mackenzie, W.** 1914. Nuove rivelazioni della specie animale, A.F. Formiggini Editore, Genova, Italy.

**Manca, L.** 1995. Il polimorfismo dell'emoglobina nei cavalli della Giara. Atti 1° Convegno scientifico sul cavallino della Giara, Tuili-Sardegna, Italy.

**Morris, D.** 1990. Horse watching, A. Mondadori Editore, Milano, Italy.

**Orlandi, M. & Pastorelli, S.** 1997. Valutazione morfo-funzionale ed etnologica del cavallo da destinare alla rieducazione equestre , Annali della Facoltà di Medicina Veterinaria, Vol. XL, Pisa, Italy.

**Papini, M. & Pasquinelli, A.** 1996. Principi pratici di riabilitazione equestre, UTET, Milano, Italy.

**Pillonca, P.** 1988. Cavalli dei nostri antenati. Incontro con Giovanni Lilliu, Caddhos, Rivista Sport Equestri, n. 32, Soter Editrice, Sassari, Italy.

**Rizzoli-Corriere della Sera.** 1983. Cavalli e cavalieri, Milano, Vol. IV, pp. 1436.

**Spano, M.L.** 1996. Metodologia per il recupero del cavallino della Giara. Relazione tirocinio laureando, facoltà di Agraria, Dipartimento di Zootecnica, Università di Sassari, Sassari, Italy.

**Tesi, L.** 1982. Piccola enciclopedia del cavallo, Edagricole, Bologna, Italy pp. 191.

**Warren Evans, J.** 1990. The horse, Freeman and Company, New York, USA.

# The Black Maltese: a Mediterranean, light breed of poultry

***J.G. Mallia***

*Department of Population Medicine, Ontario Veterinary College, University of Guelph*
***Guelph**, Ontario, Canada N1G 2W1*

## Summary

The Black Maltese is a nearly-extinct light breed of non-sitting, egg-type chicken, present in the Maltese Islands. Formerly widely reared under backyard conditions for its abundant, white eggs, it has now been entirely replaced by intensely-reared synthetic strains of poultry. This breed is also absent from the remaining backyard flocks in Malta, having been replaced by Rhode Island Red commercial strains. The Black Maltese survives in dwindling numbers as a curiosity and show-bird for poultry shows. The current spatial distribution and breed population size were determined, and breed standard was established. Suggestions on safeguarding this breed were also discussed.

## Résumé

La "Noire de Malte" est une race de pondeuse légère et non-couveuse en voie de disparition. Fournisseuse de gros oeufs blancs, elle était déjà la race préférée dans les domiciles maltais. Elle est aujourd'hui presque entièrement remplacée par les races commerciales élevées en conditions intensives. Parmi les quelques petits troupeaux qui demeurent domestiques, la noire de Malte a cédé sa place à la rouge de Rhode Island, en effet une race commerciale. A Malte, la "Noire" est de plus en plus rare, élevée seulement comme curiosité ou comme race d'exposition. Nous présentons dans cet article la distribution actuelle de la noire de Malte, ainsi qu'une énumération, une description standard de la race et une discussion de quelques mesures conservatrices.

***Key words**: Genetic resources, Chicken, Malta*

## Introduction

Mediterranean breeds are also known as "light breeds", referring to their relatively low weight and slender appearance. They are characterised by a well developed, single comb, and prominent white ear lobes. The males have a large, arched tail with prominent sickles, and the hens are non-sitting and lay white-shelled eggs. These specific characteristics distinguish them from Asian "heavy breeds". The most frequent colour of contemporary Mediterranean breeds is black (Brown, 1906); he further comments: "It is interesting to note the remarkable uniformity of type found along the northern shores of the Mediterranean Sea, extending from Spain to the Balkan States, and perhaps as far as Greece. The Spanish fowls, the La Bresse (France), Leghorn, Ancona, Valdarno (Italy), the common fowls of Austria, and the Magyar (Hungary) have a remarkable resemblance, varying in minor details as well as colour of plumage, but with uniform characteristics and qualities". However, recent selection has frequently focused on relatively few phenotypic characteristics, often to the detriment of their production characteristics. Selection was directed at "perfecting" several breeds for exhibition. For example, the Minorca was selected for a very prominent comb and large white ear lobes, possibly compromising its egg-laying


*Figure 1. The position of Malta in the Mediterranean sea.*

qualities (Anon, 1997). Likewise, the (black) Spanish was selected for the extensive areas of white skin in the face, and the Andalusian for its blue, laced feathers (Brown, 1906). The Maltese population of black poultry has largely escaped such "improvements" for show purposes, as it is virtually unknown outside its country of origin; it may therefore represent a relict population of relatively unselected poultry that formerly were characteristic of the Mediterranean.

Unselected Mediterranean poultry is probably better adapted for egg production under challenging (non-industrial) management conditions in hot and dry climates.

The principal aims of this study were to collect information regarding the Black Maltese, to quantify the present population, to establish breed standards and to explore possible similarities with poultry breeds from adjacent regions of the Mediterranean.

## Materials and Methods

Participants for the study were recruited through the use of client records of a local veterinary feed mill; these included a representative cross-section of farmers from all parts of the island for both layer and broiler chickens from January 1991 to January 1992. Persons calling the feed mill for nutrition or veterinary advice were also invited to participate (Table 1). All participants were visited on the farm-site, and a questionnaire in Maltese was orally administered, collecting information on breed characteristics, uses, and anecdotal information. The same questionnaire was administered to six further participants in May 1996; these were recruited from lists of exhibitors participating at annual animal exhibitions in the period 1993-1995, and by word of mouth. A version of the questionnaire is reported in English in table 3. Specimens of Black Maltese fowl were measured, weighed, and photographed.

## Results

Specimens of a breed of chicken known by the Maltese as "*tigieg suwed*" (=black chickens, Maltese vernacular), and as "black Maltese chickens" by the English speaking

*Table 1. Mean ± S.D. of traits measured.*

| Male[1] | Min. | Max. | Mean ± S.D.[2] |
|---|---|---|---|
| Height at base of neck (cm) | 31.0 | 32.0 | 31.5 ± 0.18 |
| Weight (kg) | 2.0 | 2.4 | 2.13 ± 0.15 |
| Height of comb (cm)[3] | 4.0 | 4.75 | 4.10 ± 0.41 |
| Ears, length (cm) | 3.0 | 3.5 | 3.28 ± 0.20 |
| Ears, width (cm) | 1.0 | 1.75 | 1.48 ± 0.25 |
| Wattles, length (cm) | 5.0 | 6.0 | 5.64 ± 0.37 |
| Wattles, width (cm) | 3.0 | 3.5 | 3.31 ± 0.18 |
| Tail (cm)[4] | 35 | 42 | 39.08 ± 2.02 |
| Female[5] | | | |
| Height at base of neck (cm) | 23.0 | 26.0 | 24.86 ± 0.79 |
| Weight (kg) | 1.1 | 1.5 | 1.28 ± 0.13 |
| Height of comb (cm)[2] | 2.0 | 2.75 | 2.39 ± 0.25 |
| Ears, length (cm) | 1.5 | 2.5 | 1.88 ± 0.40 |
| Ears, width (cm) | 0.5 | 1.0 | 0.77 ± 0.18 |
| Wattles, length (cm) | 1.5 | 2.5 | 2.10 ± 0.21 |
| Wattles, width (cm) | 2.5 | 2.7 | 2.58 ± 0.08 |
| Tail (cm) | 13.0 | 17.5 | 14.97 ±1.25 |

[1]based on 12 specimens
[2]standard deviation
[3]the base of the comb to the base of the spikes
[4]length of sickles
[5]based on 15 specimens

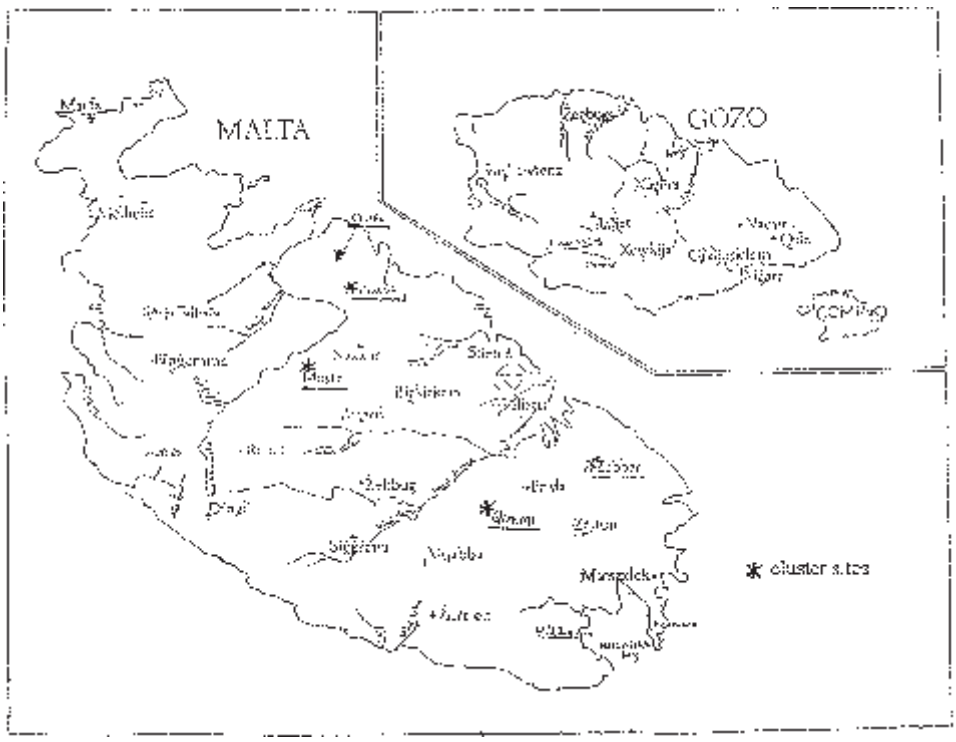



*Figure 2.The spatial distribution and clustering of Black Maltese fowl.*

*Table 2. Population data for the Black Maltese.*

| Owner I.D. | Location | Males (count) | Females (count) | Housing |
|---|---|---|---|---|
| 1 | Maghtab | 3 | 5 | backyard flock |
| 2 | Mosta | 1 | 2 | pen |
| 3 | Ghallis | 1 | 1 | exhibition cage |
| 4 | Qormi | 3 | 3 | backyard flock |
| 5 | Qormi | 3 | 3 | exhibition cage |
| 6 | Zabbar | 1 | 1 | pen |

population, were identified and described. It is the only breed of poultry associated with the Maltese islands, and was also uniformly black, as are most breeds in other Mediterranean countries; written records or illustrations describing it were not available. The position of Malta in the Mediterranean is shown in figure 1.

The Black Maltese had morphological characteristics that are typical of the Mediterranean light breeds of poultry (Figures 3 and 4). The body was broad shouldered, with a fairly long back sloping slightly to the tail and a broad breast; the wings were long and carried closely to the sides, with broad flight feathers. The plumage is close fitting, black, and with a green sheen in some males, usually localised to the tail coverts; the skin was white. The tail was prominent in both sexes, with prominent and markedly curved sickles in the male. The angle of tail with back ranged from 70° to 90°. The comb was single, with four or five points and upright in the male, bright red, smooth textured and folded over to one side without obstructing the eye in the female. The ears were white and with a single, central, longitudinal infolding; they were well demarcated from the red facial skin. The wattles were bright red, pendulant and very fine textured, the eyes were amber and prominent, and the beak was slate and horn in colour. The legs were slate and free of feathering. The carriage was upright, alert and active and they were strong fliers. The females were all non-sitting, and produced between 200 and 250 white-shelled eggs produced per annum. Other phenotypic characteristics of the breed, based on the 27 specimens (12 males, 15 females) identified in this study, are summarised in table 1.

Domestic fowl with some of these Mediterranean or light characteristics were already present in Greece and Etrusca (central Italy) in the 6th century BC, as exemplified by representations of the domestic fowl on several terracotta utensils from this period (Mallia, personal observations, 1998). All the fowls represented had a light body structure with close-fitting feathering, single combs, and well-developed tails with prominent sickles in the male. The plumage of most birds was depicted as pure black, although some fowl with wild-type feathering were present. Therefore the presence of the black phase and genes for white ears in the Mediterranean goes back to over two milleniums.

The status of the Black Maltese is critical, as few as 30 specimens were identified. The distribution of these specimens is summarized in table 2. Of the six separate groups of poultry that were identified, the Maghtab and Ghallis specimens are closely related, as are the Mosta and Zabbar specimens. Therefore this population census identified only four separate genetic pools of Black Maltese. The spatial distribution and clustering of Black Maltese fowl are shown in figure 2.

Despite the 100% participation rate of the 138 poultry growers initially visited in the questionnaire (Table 3), the Black Maltese was not identified in any of the sites visited. This was surprising as the sample included persons from across the nation and encompassed farms of various sizes and types, and also of backyard flocks. It had been

*Figure 3. Black maltese; male.*

entirely replaced by Rhode Island Red commercial strains and other heavy breeds, layers of tinted or brown eggs. However, the questionnaire revealed current and historical information regarding use and presence of the Black Maltese. This breed was formerly widely reared under backyard conditions, being the breed of choice due to its high production of large white eggs (200-250 per annum) even under poor management conditions. The non-sitting genetic trait present in the Black Maltese resulted in a longer period of egg production. It was also considerably resistant to disease (e.g.

*Table 3. Black Maltese questionnaire.*

*Owner I.D.* _____ *Locality*_____

1) Do you keep any black chickens ? Yes __ . No __. (*If not, proceed to question 9)*
2) Do you have any other chickens (i.e. not black) ? Yes __. No __.
3) What is the purpose of keeping the black chickens ? Eggs __. Meat __. Hobby/ exhibition__.
4) How many black male and female chickens do you presently own ? Males __. Females __.
5) Do you breed the black chickens with chickens of other colours ? Yes __. No __.
6) Do you breed black chickens with varying physical characteristics ? Yes __. No __.
7) What colour are the eggs from the black hens ? white __. brown / tinted __.
8) Do the black hens go broody if the eggs are left with her ? Yes __. No__.
9) Do you know of local black chickens ? Yes __. No __. (*If yes, proceed to question 10)*
10) In what context do you know of the local black chickens?
*(Tick more than one answer if necessary)*
Have heard mention of them __. Have seen them on broiler and/or egg farms __.
Have seen them at aviculture shows __. Other, please specify _____.

*Figure 4. Black maltese; trio with a male and two females.*

coccidiosis, possibly some strains of Newcastle disease), and routinely raised without the use of vaccines or antibiotics. These chickens could also reach an adequate level of production when allowed to forage, together with supplementation of household food scraps. Other breeds of chickens, in particular bantams, were used to incubate eggs and rear the young. Excess males were fattened and slaughtered for special occasions. The questionnaire also identified the main purpose for which specimens of the present population are kept, namely that for exhibition purposes.

## Discussion

The Black Maltese merits classification as a separate breed as it qualifies for all three definitions of a breed (Brock, 1987):

1. *"Selection within a population, resulting in uniform, genetically transmissible characteristics that identify it from other groups of the same species"*. The Maltese Islands formerly shared close cultural and political links with Spain and southern Italy for several centuries, encouraging the movement of poultry from these territories. The current population of Black Maltese is rarely outbred, and is a very homogeneous group of poultry with regard to body type, plumage colour and type, comb and facial characteristics and other genetically transmitted characteristics. The breed was selected for its rusticity, and production of large white eggs even in the challenging hot, arid climate that characterises the Maltese Islands.
2. *"A group of animals associated with a particular geographical area and / or farming system"*. The Black Maltese has been isolated from other Mediterranean populations possibly as early as the 1500s, when the Maltese Islands passed from Charles V of Spain to the Knights of St. John, but certainly by the early 1800s when the islands became a British protectorate. The Black Maltese has since been selected for local backyard production systems, in pens or free-range, requiring no

vaccinations or pharmaceuticals, and achieving reasonable production levels through scavenging and consumption of household waste.

3. *"A population of animals identifiable by common morphological traits and historical origins"*. The Black Maltese are distinct from other populations of backyard poultry, and there is anecdotal information suggesting that they have been historically bred pure, and resulting from a common prototype that also produced other Mediterranean breeds. However, the Black Maltese shares many phenotypic characteristics with other Mediterranean breeds and an overview of the Mediterranean breeds of poultry that most closely resemble it may be appropriate.

Many of the present Mediterranean breeds are of fairly recent origin. For example, "Spanish fowl" was the name given to all unselected fowl present in the Iberian peninsula, as recently as 1800 (Brown, 1906). Successively, a breed with a predominantly white-eared face (and not red) was developed, and called the "white-faced Spanish", to distinguish it from the " red-faced Spanish", which had white ear lobes but a red-skinned face (Brown, 1906). The former breed was known as the Black Spanish, and the latter as the Minorca (or "Portugal fowl") by the mid-1800s' (Brown, 1906). However, much of the selection for the development of these two breeds may have occurred in Spain, and Burnham (1877) suggests that the Black Spanish was brought to the USA from Holland and England. The Black Spanish illustrated by Burnham (1877) show the characteristic white face of the contemporary specimens. However the illustrations in "The American Fowl-Breeder" (Anon, 1850), published 27 years prior, show the Black Spanish with fairly "generic" Mediterranean features: "light" body structure, single comb, black close-fitting plumage, and a prominent tail with markedly curved sickles. An old illustration of the Minorca, dating to 1810 (Brown, 1906) also shows this breed having similar generic Mediterranean features. However the contemporary illustration by Brown (1906) depicts the Minorca with characteristics that are virtually identical to the present-day breed. By the late 1800s', "blue Minorcas" were already considered to be separate breed from the Minorca, and called "Andalusians" (Brown, 1906). Brown (1906) also states that the Castillian, although similar to the Minorca, is the type from which the Minorca was derived: the former is distinguished from the latter only in that it has a smaller comb and a more upright body posture. All the fore-mentioned Spanish breeds have slate-coloured legs; the Valdarno being the only Italian breed with this characteristic. Other Italian breeds such as the (black) Leghorn and Ancona have yellow legs.

To summarise, poultry with "generic" Mediterranean features was already present in Greek and Etruscan times, and until the mid 1800s' relatively unselected, non-standardised "Spanish fowl" were present on the Iberian peninsula, and possibly southern Italy. The Castillian and Black Maltese possibly represent the contemporary gene pools closest to the older, unselected (now extinct) "Spanish fowl". Breed standards have been developed for the Castillian and this report has gathered the remaining known specimens of Black Maltese with the aim of establishing breed standards. Although the Black Maltese currently survives as an exhibition bird, no attempts appear to have been made to "perfect" it for shows, other than maintain plumage colour and type, comb type etc. It is likely that the original breed production characteristics and rusticity of the Black Maltese have therefore been maintained.

The small number of specimens recorded probably represents a census of the surviving population, as all known owners of Black Maltese were contacted. The rapid decline of this breed parallels that of other backyard breeds formerly present in Malta; for example the "Egyptian chicken" (probably the gold phase of the Fayoumi) is now locally extinct. Scavenging and backyard poultry are no longer of importance to the local population, and as from the 1960's, commercial laying

hybrids with a high production potential and raised on balanced mash or pelleted diet replaced them in a short space of time. Poultry is currently only raised under industrial conditions by relatively few, specialised individuals. It is therefore unlikely that attempts to encourage the reintroduction of Black Maltese in backyard systems of management will meet with any success. Furthermore, few details are known of the actual production potential of the remnant population, and changed consumer trends have now resulted in the domestic market preferring brown eggs from free-range and backyard flocks. Historically, the Maltese population consumed exclusively white eggs; the word for "egg" in the Maltese language is "*baydah*" (= white), as all eggs produced were white.

As its present use is that of an exhibition bird, *in-situ* conservation is likely to be successful by targeting activities that centre around these activities. Hence, breed standards for the Black Maltese should be circulated around local poultry clubs. This may create an awareness of this local breed's specific characteristics, and inclusion of the characteristics given in this study with the guidelines for the judging of Black Maltese. *Ex-situ* conservation may be involved in the maintenance of breeding groups overseas since its appealing morphological features lend well to its use as an exhibition bird (Figures 2 and 3). *Ex-situ* conservation may also be achieved by the involvement of the Malta Government Farm (Ghammieri) in maintaining a breeding flock, and possibly assess the performance of this breed. Although the Black Maltese is unlikely to find use as a layer in Malta, it may be useful in other xyrothermic tropical and subtropical conditions, as does the Fayoumi (Hossary and Galal, 1994). Immediate action is necessary to safeguard the Black Maltese, as less than 30 specimens are currently known. For example, the Valdarno, formerly considered extinct (Giauarini, 1983), has been successfully revived and had reached a population size of 200 in 1994, with an increasing population trend (FAO, 1995). It is hoped that the information gathered in this study, and particularly the establishment of breed standards and a census for the Black Maltese, will be the first step in safeguarding this critically endangered breed.

## References

**Anon**, 1850. The American Fowl-Breeder. John P. Jewett & Company, Boston; 91 pp.

**Anon**, 1997. British poultry standards, 5th Edn. Blackwell Science Ltd., Oxford; pp. 368.

**Burmham, G.P.** Burnham's New Poultry Book. Lee & Shepard, Publishers, Boston; pp. 342.

**Clutton Brock, J**. 1987. A natural history of domestic mammals. Cambridge University Press and British Museum of Natural History, Cambridge and London.

**Brown**, **E**. 1906. Races of domestic poultry. Edward Arnold, London; pp. 234.

**FAO**, 1995. World Watch List for Domestic Animal Diversity, 2nd Edn. Rome; pp. 769.

**Giauarini, I.** 1983. Le razze dei polli. Edagricole, Bologna; pp. 132.

**Hossary, M.A. & Galal**, **E.S.E.** 1994. Improvement and adaptation of the Fayoumi chicken. Animal Genetic Resource Information, 14, 33-41.

# Amélioration des performances pondérales du Pigeon au Maroc par croisement de deux races locales avec une race d'origine européenne

***B. Benazzouz, A. Soulaymani & A. Mokhtari***

*Laboratoire de Pharmacologie et de Toxicologie, Unité de Génétique*
*Faculté des Sciences, Université Ibn Tofail, B.P. 133,* ***Kénitra*** *14000, Maroc*

## Résumé

Dans l'objectif de l'amélioration des performances pondérales du pigeonneau commercial au Maroc, la présente étude vise l'exploitation de l'effet bénéfique du croisement de deux races locales dites *Beldi* et *Mgandi* par la race *Sottobanca* d'origine italienne.

L'élevage est réalisé en claustration complète dans des parquets identiques soumis à des conditions sanitaires et alimentaires bien contrôlées.

La comparaison des résultats des croisements des trois races révèle une variabilité significative du poids des pigeonneaux à l'âge d'abattage (28 jours) en fonction de la race du père, de la race de la mère, de leur interaction et du sexe du pigeonneau. En outre, les différences notées entre les performances des hybrides issus de croisements réciproques semblent être liées à des effets maternels. Les meilleures conformations sont obtenues chez les pigeonneaux mâles issus du croisement d'une femelle *Sottobanca* par un mâle *Beldi* ou *Mgandi*.

Par ailleurs, l'étude comparative de l'écart de performances entre les parents et les hybrides a montré que l'expression de l'hétérosis dépend de la distance génétique entre les races croisées. Ainsi, la combinaison des deux races *Sottobanca* et *Beldi* a donné le meilleur effet hétérotique

## Summary

This study was carried out with the objective of improving the performance of squab commercial production in Morocco. Crossing was made between two local pigeon breeds: *Beldi* and *Mgandi* with the Italian breed *Sottobanaca*.

The experiment was conducted in confinement under similar conditions of feeding and sanitation for all groups.

The comparison of the crossing results of the three breeds revealed a significant variability in the weight of squabs at slaughter (28 days) due to the breed of the sires, the breed of the dam, their interaction and the sex of the squab. In addition, differences were noted between performances of the reciprocal crosses, which could be linked to maternal effects. The best conformation was that of male crossbred squab between a female *Sottobanca* and a male *Beldi* or *Mgandi*.

Furthermore, the comparative study of the gap of performances between parents and crosses has shown that the degree of the heterosis depends on the genetic distance between breeds crossed. Thus, the combination of the two breeds *Sottobanca* and *Beldi* has given the best heterotic effect.

***Key words:*** *Pigeon, Crossing, Heterosis, Weight at slaughter, Morocco, Beldi, Mgandi.*

# Introduction

Au Maroc, la production du pigeon est loin d'être satisfaisante à cause de plusieurs facteurs auxquels elle se trouve assujettie. En effet, la colombiculture se pratique uniquement dans des élevages familiaux par des croisements consanguins sans aucun choix préalable des couples et des races des reproducteurs. A ces facteurs s'ajoutent des conditions d'élevage, d'hygiène et d'alimentation aléatoires.

En présence de toutes ces contraintes, le rendement annuel des élevages reste très faible et son amélioration s'avère indispensable afin de résorber le déficit de la production de viande colombicole au Maroc.

Parmi les méthodes d'amélioration génétique des animaux domestiques, on a retenu le recours au croisement. Celui-ci permet la combinaison des aptitudes complémentaires des races croisées, ce qui se traduit par une supériorité phénotypique des hybrides par rapport à la moyenne de leurs populations parentales. Cet écart de performances entre les parents et les hybrides exprime l'effet d'hétérosis ou vigueur hybride (Falconer, 1974).

Dans le cadre de l'amélioration des performances pondérales du pigeonneau commercial au Maroc, l'utilisation du procédé de croisement apparaît limitée par les potentialités de conformation des races locales qui se caractérisent par un petit gabarit (Benazzouz *et al*., sous presse). Ainsi, l'introduction dans le modèle de croisement de races étrangères de meilleure conformation s'avère nécessaire.

La présente étude a pour but l'analyse de l'effet bénéfique du croisement de deux races locales dites *Beldi* et *Mgandi* par la race *Sottobanca* d'origine italienne sur le poids des pigeonneaux à l'âge de consommation en fonction de leur sexe. Ceci permettra l'exploitation du phénomène biologique de vigueur hybride.

*Figure 1. Un couple de la race locale Beldi.*

# Matériel et méthodes

## Races de pigeon

Nous avons utilisé trois races de pigeon:

- deux races locales *Beldi* et *Mgandi*, sélectionnées et standardisées par l'Unité de Génétique de la Faculté des Sciences de Kénitra durant plusieurs cycles de reproduction (Benazzouz *et al*., sous presse). Celles-ci sont les plus représentées et les mieux commercialisées comme pigeon de chair dans la plupart des marchés marocains. La race *Beldi*, de taille moyenne rappelant la forme typique du Biset (Figure 1), se caractérise par une cadence de reproduction très rapide et une bonne résistance aux maladies. La race *Mgandi*, de forme ramassée et bas sur pattes (Figure 2) montre une meilleure production en poids de ses descendants (Benazzouz *et al*., sous presse).
- la race *Sottobanca*, d'origine italienne, se différencie des races locales par une plus grande taille et une poitrine plus large, profonde, proéminente et bien fournie en chair (Figure 3), ce qui lui confère une meilleure conformation (Lamy, 1983). A ces avantages s'ajoute la coloration rose claire de la peau de ses pigeonneaux très appréciée par le consommateur.

Le choix de la race *Sottobanca* est basé sur son origine éloignée et sur ses différences de conformation par rapport aux races locales afin d'introduire le maximum de variabilité dans les croisements.

## Croisements

L'expérimentation consiste en l'obtention des descendants du croisement des trois races de

*Figure 2. Un couple de la race locale Mgandi.*

*Figure 3. Un couple de la race italienne Sottobanca.*

*Figure 4. Vue générale des parquets d'élevage.*

pigeon choisies selon un schéma diallèle complet: soient neuf combinaisons possibles.

Ainsi, chaque type de croisement, représenté par cinq couples reproducteurs, est placé dans un parquet d'élevage isolé afin d'éliminer tout risque de variation du type d'union.

Les couples reproducteurs, choisis d'âges comparables (12 à 16 mois), sont formés de manière à éviter les croisements consanguins à effets néfastes sur les performances des élevages (Soulaymani *et al*., 1997 sous presse).

## Conditions d'élevage

L'élevage est réalisé en claustration complète dans neuf parquets identiques et indépendants composé chacun de six pondoirs à double case disposés en damier (Figures 4 et 5). La présence d'un pondoir supplémentaire évitera la compétition pour les nids. Chaque couple dispose d'un nid double permettant à la pigeonne d'entamer une nouvelle ponte avant la descente de ses jeunes de la couvée précédente. La densité est de trois couples par $m^2$ afin de supprimer les effets défavorables de la surcharge sur la productivité des parquets d'élevage. Ceux-ci sont munis de mangeoires et d'abreuvoirs identiques à ceux décrits par Le Douarin et Kerharo (1992).

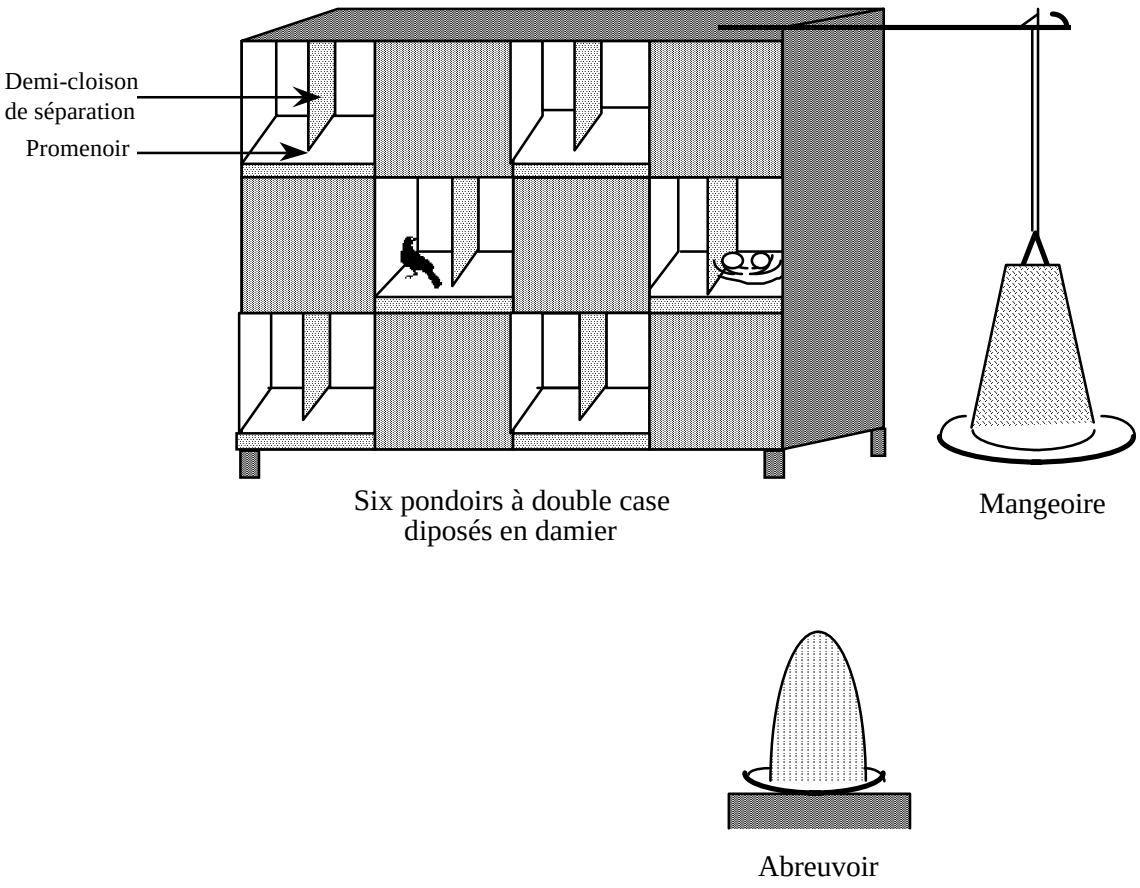



*Figure 5. Organisation schématique d'un parquet d'élevage.*

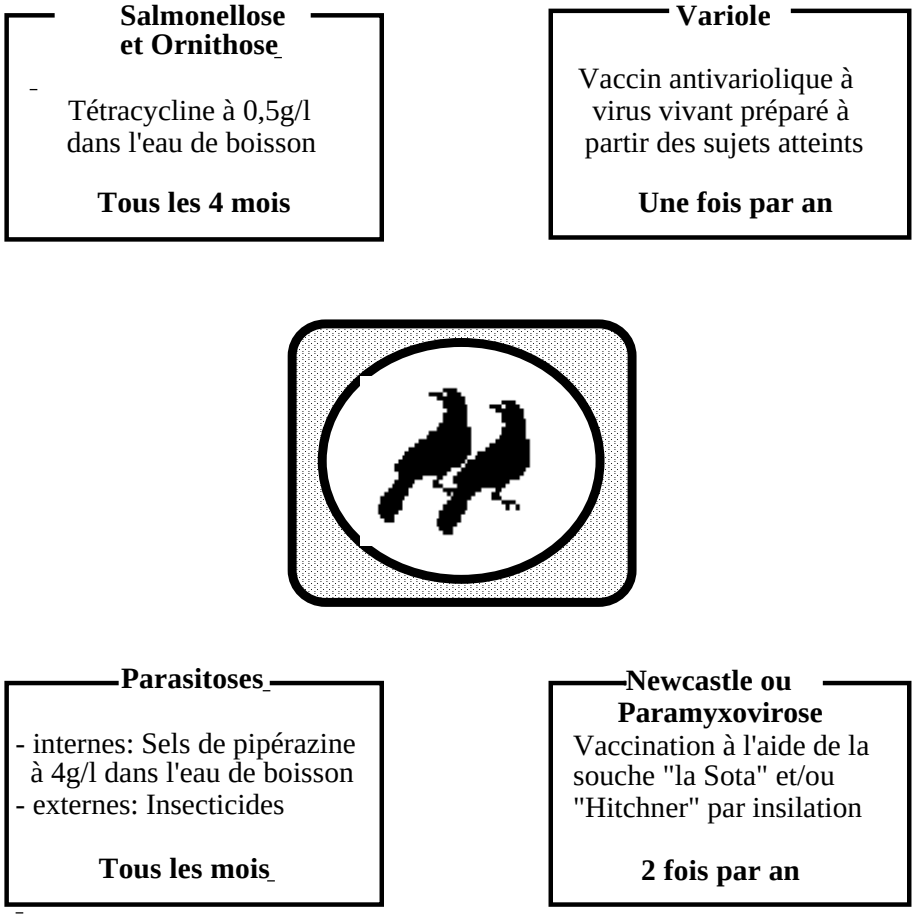



*Figure 6. Le plan prophylactique*

L'alimentation des pigeons est composée de céréales à raison de 40% de maïs, 30% de blé et 30% de légumineuses, auxquels sont ajoutés du calcium, du chlorure de sodium et des vitamines (Duchatel, 1996).

En outre, sachant l'influence de l'état sanitaire des oiseaux sur leur production, un plan prophylactique a été adopté durant la période d'élevage (Figure 6) afin de prévenir les infections virales, bactériennes et parasitaires (Tudor, 1991; Benazzouz *et al.*, 1996).

## Caractère étudié et méthodes d'analyses

L'étude a porté sur l'analyse du poids moyen des descendants à l'âge d'abattage (28 jours) en fonction de la race du père, de la race de la mère et du sexe des pigeonneaux.

Il est à noter qu'à cause de l'absence du dimorphisme sexuel chez le pigeonneau d'un mois, le sexage n'est effectué qu'à l'âge de trois mois par l'examen des orifices génitaux à l'intérieur du cloaque (Bénoît, 1986).
La correspondance des données, prises à l'âge de 28 jours et à trois mois, est réalisée à l'aide de fiches individuelles établies selon le modèle de Bénoît (1986). Les pigeonneaux sont marqués dès la première semaine après l'éclosion par des bagues de la Société Nationale de Colombiculture (S.N.C. - France) portant un numéro d'ordre et l'année de naissance (Figure 7).

Seules les couvées comportant deux pigeonneaux sont considérées dans cette analyse afin d'éliminer les variations du poids dues au nombre de pigeonneaux par couvée. Les pesées sont réalisées à la même heure et sont effectuées à l'aide d'une balance de précision à $10^{-2}$ grammes près.

*Figure 7. Mise en place de la bague chez le pigeonneau.*

L'analyse statistique est effectuée par la procédure GLM du logiciel SAS qui tient compte des effectifs déséquilibrés. La variabilité du poids des pigeonneaux à l'âge d'abattage est analysée selon un modèle à effets fixés comprenant les effets des facteurs race du père, race de la mère, sexe du pigeonneau et l'interaction race du père x race de la mère. La comparaison multiple des moyennes est réalisée par le test de Duncan chaque fois que l'analyse de la variance révèle des différences significatives.

Par ailleurs, afin d'analyser la différence entre le poids des descendants des races parentales et de leurs hybrides, nous avons estimé la valeur de l'hétérosis ($H_{F1}$) par l'écart entre les performances moyennes des hybrides de première génération ($M_{F1}$) et celles du parent moyen ($M\bar{p}$ ):

$$H_{F1} = M_{F1} - M\bar{p}$$

La signification de l'écart $H_{F1}$ par rapport au parent moyen est analysée par le test «t» de Student-Fisher.

L'effet de l'hétérosis est exprimé également en pourcentage par rapport au parent moyen:

$$H_{F1} = \frac{M_{F1} - M\bar{p}}{M\bar{p}} \times 100$$

Ce modèle permettra la comparaison des quantités d'hétérosis pour différents croisements.

# Résultats et Interprétations

## Analyse des performances pondérales des pigeonneaux à l'âge de sevrage

Les poids moyens des pigeonneaux à l'âge d'abattage des trois races et de leurs hybrides de première génération en fonction de leur sexe sont consignés au tableau 1. Les résultats de l'analyse de la variance ainsi que la comparaison multiple des moyennes des performances pondérales des pigeonneaux selon les facteurs race du père, race de la mère

et leur sexe sont indiqués respectivement aux tableaux 2 et 3.

L'analyse de la variance a révélé des effets hautement significatifs de la race du père et de la race de la mère sur le poids des pigeonneaux à l'âge d'abattage (P<0,001).

L'écart entre le poids des pigeonneaux issus des trois races paternelles est de 32,4 g. La comparaison multiple des moyennes montre que les pigeonneaux de père *Sottobanca* présentent les poids les plus élevés par rapport à ceux issus des races paternelles locales (Tableau 3).

En outre, la différence entre les poids des pigeonneaux provenant des trois races maternelles atteint 80g. Ainsi, la meilleure performance est obtenue chez les pigeonneaux de mère *Sottobanca* (469,7 g) alors que le poids le plus faible est enregistré chez les descendants issus de la race maternelle *Beldi* (390,09 g).

Par ailleurs, l'interaction entre les facteurs race du père x race de la mère a révélé une influence très significative sur le poids des pigeonneaux à l'âge de 28 jours (P<0,001). Ainsi, la variabilité des performances pondérales des pigeonneaux à l'âge de sevrage dépend également des interactions entre le génotype maternel et paternel (effets non-additifs).

De plus, l'analyse des résultats a reflété l'effet non génétique du facteur sexe sur le poids des pigeonneaux à l'âge d'abattage. La différence moyenne de poids entre les deux sexes est de 34 g.

La combinaison des effets génétiques (race du père, race de la mère et leur interaction) et de l'effet du facteur sexe attribue le plus faible poids aux pigeonneaux femelles issus de parents de la race *Beldi* (339,56 g) et la

*Tableau 1.Variation du poids des pigeonneaux à l'âge de 28 jours des trois races et de leurs hybrides en fonction de leur sexe avec comparaison des moyennes (Test de Duncan).*

| Poids (g) | Pigeonneaux mâles | | | Pigeonneaux femelles | | | Sexes confondus | | |
|---|---|---|---|---|---|---|---|---|---|
| Croisements ♀ x ♂ | N | $\bar{x}$ | E.S | N | $\bar{x}$ | E.S | N | $\bar{x}$ | E.S |
| S x B | 43 | 488,47 $^{a}$ | 1,17 | 35 | 449,79 $^{a}$ | 1,22 | 78 | 471,11 $^{a}$ | 2,35 |
| S x M | 33 | 487,02 $^{ab}$ | 1,17 | 27 | 448,87 $^{a}$ | 1,40 | 60 | 469,85 $^{ab}$ | 2,63 |
| S x S | 28 | 484,75 $^{b}$ | 1,40 | 24 | 447,19 $^{a}$ | 1,50 | 52 | 467,41 $^{b}$ | 2,81 |
| M x S | 33 | 480,42 $^{c}$ | 1,21 | 27 | 441,68 $^{b}$ | 1,37 | 60 | 462,99 $^{c}$ | 2,66 |
| M x M | 30 | 447,73 $^{d}$ | 1,30 | 24 | 413,78 $^{c}$ | 1,37 | 54 | 432,64 $^{d}$ | 2,50 |
| B x S | 44 | 429,99 $^{e}$ | 1,07 | 36 | 396,72 $^{d}$ | 1,19 | 80 | 415,02 $^{e}$ | 2,02 |
| M x B | 43 | 425,23 $^{f}$ | 1,04 | 35 | 391,70 $^{e}$ | 1,20 | 78 | 410,18 $^{f}$ | 2,05 |
| B x M | 46 | 414,02 $^{g}$ | 0,91 | 38 | 382,55 $^{f}$ | 1,11 | 84 | 399,78 $^{g}$ | 1,86 |
| B x B | 43 | 365,88 $^{h}$ | 1,02 | 35 | 339,56 $^{g}$ | 1,10 | 78 | 354,07 $^{h}$ | 1,66 |

N: effectif

$\bar{x}$ : moyenne

E.S: erreur standard

$\bar{x}^{(a, b, c)}$: les moyennes affectées de lettres différentes dans une même colonne sont significativement différentes au seuil de 5%.

S: *Sottobanca*; M: *Mgandi*; B: *Beldi*.

*Tableau 2. Analyse de la variance du poids des pigeonneaux à l'âge de 28 jours et signification du rapport F.*

| Variable | Source de variation | S.C.E | λ | Variance | F | Probabilité (signification) |
|---|---|---|---|---|---|---|
| Poids des pigeonneaux à l'âge d'abattage (g) | Race du père (A) | 112 517,53 | 2 | 56 258,76 | 1 081,99 | < 0,001 (***) |
| | Race de la mère (B) | 730 809,52 | 2 | 365 404,76 | 7 027,59 | < 0,001 (***) |
| | Sexe du pigeonneau | 182 237,44 | 1 | 182 237,44 | 3 504,85 | < 0,001 (***) |
| | Interaction (AxB) | 92 710,11 | 4 | 23 177,53 | 445,76 | < 0,001 (***) |
| | Résiduelle | 31 925,37 | 614 | 51,996 | | |
| | Totale | 1 150 199,97 | 623 | | | |

S.C.E: somme des carrés des écarts; l: degré de liberté
(***): différences significatives à 1‰.

*Tableau 3. Comparaison multiple des moyennes selon les facteurs étudiés pour le poids des pigeonneaux à l'âge de sevrage (28 jours) -Test de Duncan-.*

| Poids des pigeonneaux (g) | | N | $\bar{X}$ | E.S |
|---|---|---|---|---|
| Selon la race du père | *Sottobanca* | 192 | 444,20[a] | 2,27 |
| | *Mgandi* | 198 | 429,98[b] | 2,47 |
| | *Beldi* | 234 | 411,79[c] | 3,34 |
| Selon la race de la mère | *Sottobanca* | 190 | 469,70[a] | 1,48 |
| | *Mgandi* | 192 | 433,00[b] | 2,11 |
| | *Beldi* | 242 | 390,09[c] | 1,97 |
| Selon le sexe du pigeonneau | Mâle | 343 | 442,91[a] | 2,22 |
| | Femelle | 281 | 408,77[b] | 2,23 |

N: effectif
$\bar{X}$ : moyenne
E.S: erreur standard
$\bar{X}$ (a, b, c): les moyennes affectées de lettres différentes dans une même ligne sont significativement différentes au seuil de 5%.

meilleure conformation aux hybrides mâles (488,47 g) provenant du croisement d'un parent femelle *Sottobanca* par un parent mâle *Beldi* (Figure 8).

Indépendamment du facteur sexe, l'analyse de la figure 9 montre que les plus lourds pigeonneaux sont obtenus par le croisement d'une femelle *Sottobanca* par un mâle *Beldi* ou *Mgandi*. De plus, les performances des hybrides des deux races locales s'avèrent meilleures par rapport à celles des descendants de la race *Beldi*.

En outre, le poids des pigeonneaux dépend également du sens du croisement, étant donné les différences significatives notées entre les performances des hybrides issus de croisements réciproques. Ces différences semblent être liées en partie à des effets maternels. En effet, la taille et le poids de l'oeuf varient proportionnellement avec la conformation du parent femelle (Ricard et Blocher, 1990). Des résultats analogues sont obtenus par Hanafi *et al*. (1991) à l'issu du croisement de quatre races de poulet.

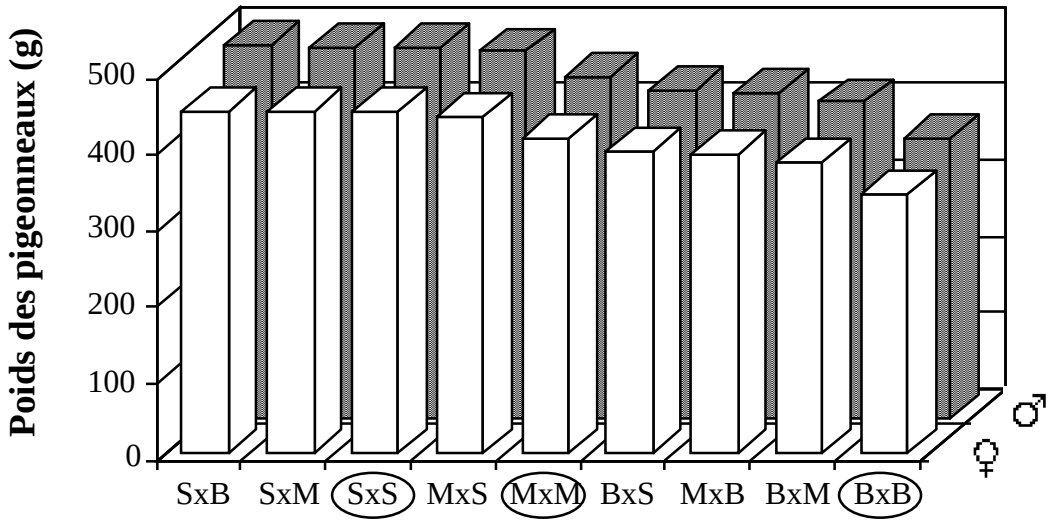



*Figure 8. Variation du poids des pigeonneaux à l'âge d'abattage des diverses races utilisées et de leur hybrides en fonction de leur sexe.*

### Analyse de l'effet hétérosis sur le poids des pigeonneaux à 28 jours

Les estimations de l'effet hétérosis des différents croisements ainsi que leurs significations sont consignées dans le tableau 4.

L'analyse des résultats révèle, chez les deux sexes, une variabilité des quantités d'hétérosis en fonction du type de croisement. Toutes les valeurs d'hétérosis obtenues s'avèrent hautement significatives (P<0,001).

Par ailleurs, indépendamment du sexe des pigeonneaux, le croisement de la race *Sottobanca* par la race locale *Beldi* fournit les hybrides les plus vigoureux ($H_{F1}$=7,8%), alors que le croisement des races locales donne les plus faibles effets hétérotiques ($H_{F1}$ = 2,96%) (Figure 10). Ce résultat est logique dans la mesure où l'expression de l'hétérosis est plus accentuée lorsque les races croisées sont plus éloignées (Falconer, 1974; Brun, 1992).

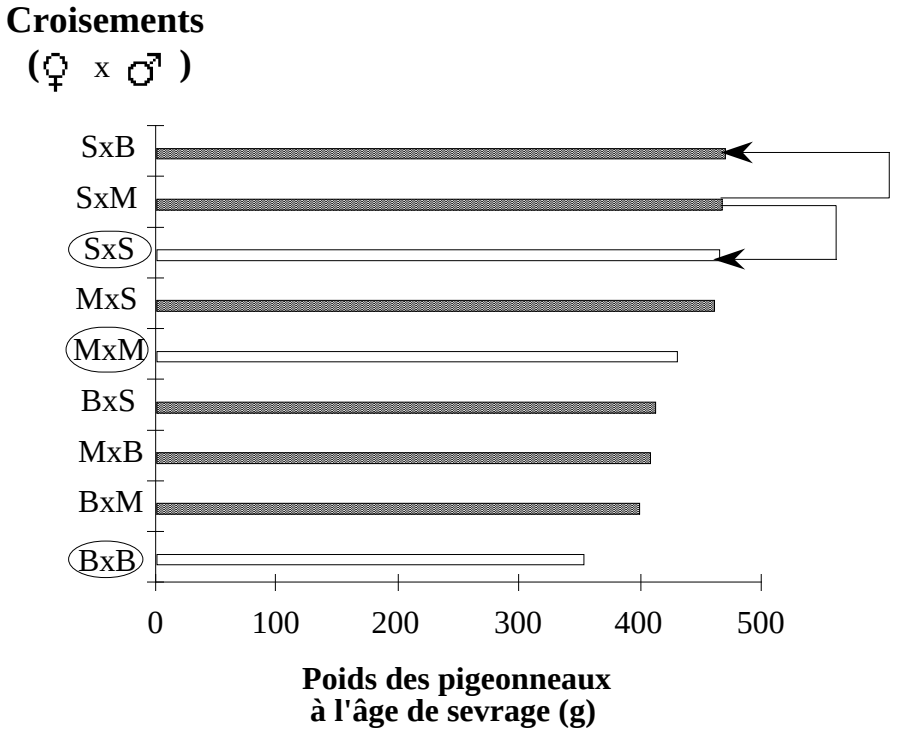
## Discussion

L'analyse globale des résultats de cette étude permet de démontrer l'effet bénéfique du croisement des deux races locales *Beldi* et *Mgandi* par la race italienne *Sottobanca* sur l'amélioration des performances pondérales des pigeonneaux à l'âge de consommation (28 jours). Ceci peut s'expliquer par le fait que le croisement réunit chez l'hybride, en une seule génération, d'une part les qualités acquises par de nombreuses années de sélection dans chaque population parentale et d'autre part l'amélioration supplémentaire due à l'effet d'hétérosis.

*Tableau 4. Estimation de l'effet hétérosis des différents croisements pour le poids des pigeonneaux à l'âge d'abattage en fonction de leur sexe.*

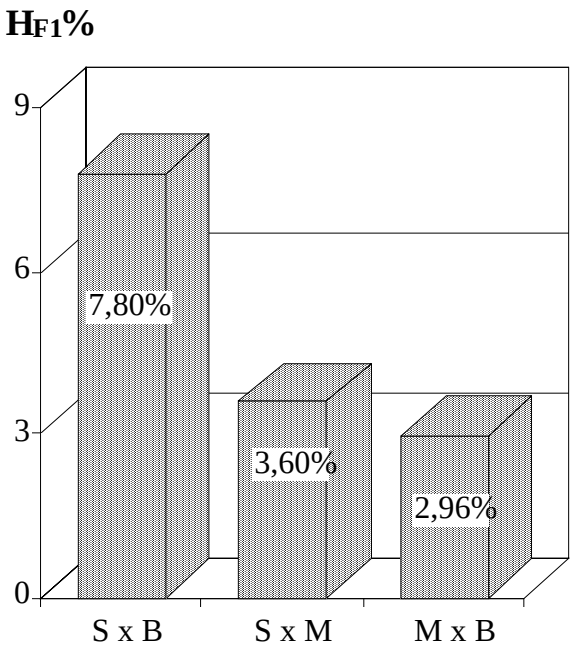
| Poids (g) | Croisements | $H_{F1}$ | E.S | $H_{F1}$ (%) | Signification |
|---|---|---|---|---|---|
| Pigeonneaux mâles | S x B | 34,11 | 1,65 | 8,03 | *** |
| | S x M | 17,67 | 1,58 | 3,79 | *** |
| | M x B | 12,51 | 1,42 | 3,07 | *** |
| Pigeonneaux femelles | S x B | 29,80 | 1,68 | 7,57 | *** |
| | S x M | 14,67 | 1,92 | 3,41 | *** |
| | M x B | 10,68 | 1,56 | 2,84 | *** |
| Sexes confondus | S x B | 31,96 | 1,64 | 7,80 | *** |
| | S x M | 16,17 | 1,75 | 3,60 | *** |
| | M x B | 11,60 | 1,48 | 2,96 | *** |

S: *Sottobanca;* M: *Mgandi;* B: *Beldi*.
$H_{F1}$: Valeur de l'hétérosis
E.S: erreur standard
$H_{F1}$: Pourcentage de l'hétérosis exprimé par rapport au parent moyen
***: Valeur de l'hétérosis significative à 1‰.




S: *Sottobanca;* M: *Mgandi;* B: *Beldi*.
(Les croisements réunis par le même trait ne montrent pas de différences significatives au seuil de 5% quant au poids de leurs pigeonneaux)

*Figure 9. Classement des différents croisements selon le poids de leurs pigeonneaux à l'âge d'abattage (sexes confondus).*




S: *Sottobanca*; M: *Mgandi*; B: *Beldi*.

*Figure 10. Variation du pourcentage d'hétérosis pour le poids des pigeonneaux à l'âge d'abattage au niveau des différents croisements (sexes confondus)*

L'expression de l'hétérosis, résultant de la combinaison des facteurs dominants chez l'hybride, varie en importance selon la distance génétique entre les races parentales. Ainsi, le croisement doit être effectué entre des races génétiquement éloignées afin d'optimiser simultanément l'utilisation des effets additifs (différences entre races) et non-additifs (hétérosis) des gènes (Gregory *et al*., 1982).

Selon les résultats du présent travail, l'introduction de races d'origines étrangères dans le plan de croisement tel que le *Sottobanca*, pourra contribuer à l'augmentation du poids des pigeonneaux à l'âge de mise en marché.

Le choix des races parentales et de leur combinaison doit se baser sur diverses composantes telles que la conformation et la qualité de bons nourrisseurs, étant donnée la nature nidicole des pigeonneaux et leur dépendance totale de leurs parents jusqu'à l'âge d'abattage. Ces composantes dépendent elles-mêmes de facteurs héréditaires, de l'environnement et de l'interaction génotype-environnement. Celle-ci constitue une source de variation des valeurs phénotypiques soit en modifiant le classement des génotypes d'un milieu à l'autre, soit en réduisant la différence entre les génotypes sans changer leur classement (Falconer, 1974).

Ainsi, l'amélioration de la production pondérale du pigeonneau commercial au Maroc par le procédé de croisement nécessite un choix préalable des races parentales et de leur combinaison. Aussi, l'adoption de conditions d'élevage, d'hygiène et d'alimentation bien contrôlées durant la période de production serait indispensable afin de réduire les effets du milieu et de l'interaction génotype-environnement sur le rendement des élevages. Ceci permettra d'exploiter le gain de poids dû à l'hétérosis qui est fonction des populations parentales et de l'environnement (Brun, 1992).

## Références

**Benazzouz, B., Soulaymani, A. & Mokhtari A.** 1996; Étude comparative des effets des couvées de deux et de trois oeufs sur la production des pigeonneaux de chair. Actes Inst. Agron. Vét. (Maroc) 16(4), 21-28.

**Benazzouz, B., Soulaymani, A. & Mokhtari, A.** Sous presse. Caractérisation et étude comparative de deux races de pigeon de chair du Maroc. Actes Inst. Agron. Vét. (Maroc).

**Benoît, R.** (Ed.) 1986; Élevage du pigeon de chair. Ed. Point Vétérinaire, Maisons-Alfort., 167pp.

**Brun, J.M.** 1992; Les bases de la génétique quantitative - Définition et mesure des paramètres du croisement. INRA Prod. Anim., hors série, 101-105.

**Duchatel, J.P.** 1996; L'alimentation du pigeon. Colombiculture 105, 20-21.

**Falconer, D.S.** (Ed) 1974; Introduction à la génétique quantitative. Masson et Cie (Ed.). Paris, pp. 284.

**Gregory, K.E., Trail, J.C.M., Koch, R.M. & Cundiff, L.V.** 1982; Heterosis, crossbreeding and composite breed utilisation in the tropics. In Second World Congress on genetics applied to animal production. Madrid, 279-292.

**Hanafi, M.S., Khalil, M.H., Ezzeldin, Z.A. & Sabra, Z.A.** 1991; Estimation of heterosis and combining abilities for body weights and measurements in chickens. Egyptian Journal of Animal Production 28(2), 191-210.

**Lamy, R.** (Ed), 1983; Standards pigeons adoptés par la S.N.C. Imp. La Frontière-Belfort.

**Le Douarin, P. & Kerharo, A.** (Ed), 1992; L'habitat du pigeon de rapport: Bâtiment neuf, aménagement, équipement d'un pigeonnier. Ed. ITAVI, pp. 48.

**Ricard, F.H. & Blocher, F.** 1990; Effets génétiques non additifs concernant la qualité de poulets obtenus par croisements entre lignées lourdes et légères. European poultry conference, Barcelona 25-28 June, 492-496.

**Soulaymani, A., Benazzouz, B. & Mokhtari, A.** 1997; Incidence de la consanguinité sur la viabilité des pigeonneaux. Rev. Fac. Sci. Marrakech (Maroc) 9, 32-38.

**Soulaymani, A., Benazzouz, B. & Mokhtari, A.** Sous presse; Dépression de la consanguinité sur les performances pondérales des pigeonneaux. Actes Inst. Agron. Vét. (Maroc).

**Tudor, D.C.** (Ed), 1991; Pigeon health and disease. Ames, Iowa (USA). Iowa State University Press. 244pp.

**Wolf, J. & Knizetova, H.** 1994; Crossbreeding effects for body weight and carcass traits Sin Pekin duck. British Poultry Science 35(1), 33-45.

# Caractéristiques morphobiométriques de la poule du Sénégal

*A. Missohou[1], R.S. Sow[2] & C. Ngwe-Assoumou[1]*

*[1]Service de Zootechnie-Alimentaion, Ecole Inter-Etats des Sciences et Médecine Vétérinaires (EISMV), BP 5077* ***Dakar****, Sénégal*
*[2]Laboratoire de Hann, Institut Sénégalais de Recherche Agronomique (ISRA),* ***Dakar****, Sénégal*

## Résumé

Cette étude, qui vise à étudier les caractéristiques morphobiométriques de la poule du Sénégal, a porté sur 1 598 sujets échantillonnés dans deux zones agro-écologiques différentes: la zone de Dahra au centre du Sénégal et la zone de Kolda située en Casamance au sud du pays.

Chaque sujet a fait l'objet d'une description par observation directe et d'une pesée. La longueur du tarse a également été objet d'une mesure.

La coloration du plumage de la poule Sénégalaise est très variée mais les principales dominantes sont le fauve (13,82%), le blanc (12,39%), le mille-fleurs (8,38%), le blanc et fauve (8,38%) et le fauve herminé (7,85%). Les phénotypes "frisé" et "cou nu" représentent respectivement 0,9% et 1,94% de la population, ce qui correspond aux fréquences 0,5% du gène frisé (F) et 1% du gène cou nu (Na). La peau et les pattes sont surtout blanches mais elles peuvent aussi être jaunes, roses ou bleu acier (pattes).

Le poids moyen des sujets est de 1,02±0,337 kg pour une longueur du tarse de 9,21 cm. Le nombre d'oeufs pondus par poule est de 12,4. Ce sont des oeufs en majorité (73%) blancs qui pèsent en moyenne 31,7±3,9 g.

## Summary

Data on 1 598 birds from two ecological zones (Dahra in the central part of Senegal and the area of Casamance, in the south) were analysed to characterise the Senegal chicken. Each bird was described phenotipically, weighed and the length of its metatarsus measured.

The Senegal chicken varies in colour, but the most frequent colours are brown (13.8 %), white (12.4 %), yellowish (8.4 %), white and brown (8.4 %), and light brown (7.8 %).

The "curly" and the "peel neck" phenotypes represent 0.9% and 1.94% of the whole population, respectively. These correspond to frequencies of 0.5 % for the curly gene (F) and 1% for the peel neck gene (Na).

The skin and the legs are generally white, but in some cases they can be yellow, pink or blue. The average liveweight of the chicken is 1.02±0.337 kg with an average tarsus length of 9.21 cm. The egg number per hen is 12.4. Generally egg shell is white (73%). The average egg weight is 31.7±3.9 g.

***Key words****: Poule locale, Casamance, Breeding, Characteristics.*

## Introduction

Malgré le fulgurant essor de l'aviculture au Sénégal, la poule locale constitue encore plus de 80% des effectifs de poules recensées dans le pays. Sa bonne adaptation à des conditions d'élevage précaires à fait d'elle une source de protéines et de revenus facilement mobilisable en milieu villageois. De plus elle est très

recherchée pour sa pigmentation et pour la saveur de sa chair et de ses oeufs (Mukherjee, 1990).

Malgré ses qualités, peu de données techniques existent sur la poule Sénégalaise en terme de performances, d'études comparatives avec les races exotiques, d'adaptabilité et de résistance aux maladies locales (Horst, 1988). Par ailleurs, elle fait l'objet de croisements désordonnés avec les races exotiques qui risquent à terme, comme ce fut le cas dans plusieurs pays développés (Crawford, 1990) de la mettre en péril.

Face à la nécessité de préserver les ressources génétiques actuelles pour mieux affronter les défis de demain, notre laboratoire a commencé une étude de caractérisation de la poule Sénégalaise dont la première étape est l'étude des caractéristiques morphobiométriques.

# Matériels et méthodes

## Sites d'étude

L'étude s'est déroulée dans deux zones agro-écologiques différentes: les zones de Dahra dans le Djoloff et de Kolda en Casamance. Localisé à la croisée du 15° de latitude Nord et du 15° longitude Ouest, le Djoloff présente un climat à faible pluviométrie (200 mm/an répartis sur 3 mois) à hygrométrie comprise entre 30-35% et une température moyenne annuelle de 28°C. La Casamance quant à elle est située au sud du Sénégal avec un climat plus humide (1 200 mm de pluie/an, 88% d'hygrométrie) et une température moyenne de 27,7°C.

## Collecte et analyse des données

L'étude a porté sur des sujets de race locale dont 1 044 proviennent de Kolda et 554 de Dahra. Les caractères phanéroptiques (type, répartition des plumes, couleur du plumage, peau...) ont été déterminés par observation

*Figure 1. Coq hermine de race locale (à gauche) et poule blanche de race locale (à doitre).*

*Tableau 1. Coloration du plumage chez la poule du Sénégal (en % de l'effectif total).*

| | Regions | | Total |
|---|---|---|---|
| | Kolda | Dahra | |
| Fauve | 6,6 (78) | 25,8 (143) | 13,52 (216) |
| Blanc | 16,4 (171) | 4,9 (27) | 12,39 (198) |
| Mille-fleurs | 9,5 (99) | 6,3 (35) | 8,38 (134) |
| Blanc et fauve | 8,9 (93) | 7,4 (41) | 8,38 (134) |
| Fauve herminé | 9,6 (100) | 4,7 (26) | 7,85 (126) |
| Coucou | 5,8 (61) | 5,2 (29) | 5,63 (90) |
| Chamois | 4,3 (45) | 7,4 (41) | 5,38 (86) |
| Blanc et noir | 6,2 (65) | 3,4 (19) | 5,26 (84) |
| Rouge et noir | 3,9 (41) | 5,8 (32) | 4,57 (73) |
| Rouge | 1,7 (18) | 9,0 (50) | 4,25 (68) |
| Rouge doré | 2,4 (25) | 7,2 (40) | 4,07 (65) |
| Noir | 3,3 (34) | 0,9 (5) | 2,44 (39) |
| Noir et fauve | 3,0 (32) | 1,3 (7) | 2,31 (37) |
| Caille | 2,8 (29) | 1,5 (8) | 2,31 (37) |
| Herminé | 1,6 (17) | 0,7 (4) | 1,3 (21) |
| Autres (Perdrix doré, saumoné, argenté...) | 13,0 (136) | 8,0 (47) | 11,45 (185) |

*() Effectifs observés*

*Tableau 2. Répartition des plumes chez la poule Sénégalaise (en % de l'effectif total).*

| | Regions | | Total |
|---|---|---|---|
| | Kolda | Dahra | |
| Normal | 88,6 (925) | 80,86 (448) | 85,92 (1373) |
| Cou nu | - | 5,59 (31) | 1,94 (31) |
| Tarse et métatarse emplumés | 1,9 (20) | 4,33 (24) | 0,9 (44) |
| Huppe | | | |
| Cou nu et huppe | - | 9,02 (50) | 9,26 (148) |
| Tarse et métatarse | | | 0,06 (1) |
| emplumés et huppe | 0,1 (1) | - | 0,06 (1) |

*() Effectifs observés*

directe de chaque poule en utilisant la fiche proposée par la FAO. Les oiseaux et les oeufs ont été pesés à l'aide d'une balance électronique portable, leur tarse mesuré à l'aide d'un ruban et leur âge déterminé à partir des déclarations des éleveurs. Les analyses statistiques descriptives (fréquence, écart-type, table-croisée...) ont été faites en se servant du logiciel SPSS/PC.

# Résultats et discussion

## Phanéroptique

### *Plumage*

Chez la poule du Sénégal, le plumage est très varié mais les colorations les plus fréquentes sont le fauve (13,82%) très présent à Dahra

*Tableau 3. Poids et longueur du tarse chez la poule du Sénégal.*

| | Age | | |
|---|---|---|---|
| | < 6 mois | 6-12 mois | < 12 mois |
| Poids (g) | | | |
| Espèce | 778 | 1010 | 1269 |
| Mâle | 846 | 1248 | 1697 |
| Femelle | 738 | 920 | 1155 |
| Longueur du tarse (cm) | | | |
| Espèce | 8,91 | 9,19 | 9,21 |
| Mâle | 9,75 | 10,63 | 10,59 |
| Femelle | 8,42 | 8,65 | 8,85 |

*Figure 2. Poulailler traditionnel.*

(26%) et le blanc (12,39%) qui est plus fréquent à Kolda (16,4%). Les autres couleurs rencontrées sont le mille-fleurs, le coucou, le chamois...(tableau 1). Les plumes sont de deux types: le type normal qui constitue l'essentiel (99,1%) de l'échantillon et le frisé. Ce dernier type a également été décrit dans l'ancien Dahomey sous le nom de "*Ayada kidié*" (Doutressole , 1947). S'agissant de la répartition des plumes (tableau 2), la huppe est présente chez 9,3% des poules alors que seulement 0,9% d'entre elles ont le tarse et le métatarse emplumés. Quand au phénotype cou nu encore appelé "Ndaré" dans le bassin arachidier Sénégalais (Buldgen *et al*., 1992) il représente 1,94% des oiseaux. En supposant la population en équilibre de Hardy-Weinberg étant donné sa grande taille et son mode de reproduction aléatoire, les

fréquences respectives des allèles frisé (F) et cou nu (Na) sont de 0,5% et 1%.

### *Peau, pattes et appendices*

La peau est blanche (93,4%), rose (3,7%) ou jaune (3,7%). Les mêmes couleurs se retrouvent (56,5%, 17,3%, 7,0%, respectivement) au niveau des pattes qui peuvent en plus être bleu acier.

Les oreillons blancs sont les plus rencontrés (78%). Mais le rouge (3,6%), le sablé (7,6%), le blanc centré rouge (3,9%) ou l'inverse (6,9%) sont également présents dans la population de la présente étude. Environ 3,3% des oiseaux n'ont pas de crête. La crête simple est la plus fréquente (81,6%) contre 13,9% de crête rose, 4,3% de crête en pois et de 0,06% en corne.

## Performances

### *Croissance et longueur du tarse*

Le poids moyen de la poule locale est de 1,020±0,337 kg soit un coefficient de variation de 33%. Il varie en fait de 0,778 kg chez les oiseaux âgés de 1-6 mois à 1,01 kg chez les oiseaux de 6-12 mois et à 1,269 kg chez les oiseaux adultes. A ces différents âges, les mâles sont de 15%, 36% et de 47% plus lourds que les femelles (tableau 3). Ces poids , tout au moins ceux observés chez les femelles, sont très proches de ceux observés au Nigeria (Binwagu et Nwosu, 1991) mais sont très inférieurs par rapport aux résultats de Buldgen *et al*. (1992). La croissance est très faible et est d'environ 2,8 g/jour entre 1 et 6 mois et de 1,19 g/jour entre 6 mois et un an d'âge. Elle est certainement le résultat du

*Figure 3. Couple de poules dans la cour de la concession (à gauche) et Coq rouge de race locale (à doitre).*

*Figure 4. Complementation alimentaire en aviculture traditionnelle.*

faible niveau d'amélioration génétique de la race puisqu'une amélioration des conditions d'élevage affecte peu les performances de croissance de la poule locale (Buldgen *et al*., 1992). La longueur du tarse est en moyenne de 9,1 cm.

***Ponte***

Pour la détermination du nombre d'oeufs par couvée, n'ont été prises en considération que les poules en couvaison. Le nombre moyen d'oeufs pondus est de 12,4 par couvée. En admettant un intervalle entre pontes de 2 mois (Buldgen *et al*. 1992), le nombre total d'oeufs pondus annuellement est de 60. Il est supérieur à celui observé par ces auteurs dans le bassin arachidier et par Nayak (1994) chez la poule Desi en Inde. Buldgen *et al*. (1992) ont, en faisant passer la poule du milieu traditionnel en station, multiplié par deux le nombre d'oeufs pondus par poule et ont ainsi montré le rôle important joué par les mauvaises conditions d'élevage sur l'aptitude à la ponte de la poule locale.

Les oeufs sont dans 73% des cas blancs contre seulement 27% de roux. Ils pèsent en moyenne 31,7± 3,5 g. Ce poids présente peu de variation en fonction du numéro de ponte et de la région.

## Conclusion

La poule Sénégalaise présente une grande diversité, tant dans sa phanéroptique que dans ses performances signe de la primarité de la race. Cette grande diversité peut servir de base à la création de souches rustiques et plus performantes. Une amélioration concomitante des conditions d'élevage devrait permettre d'accroître notablement la productivité de la poule locale et en faire, surtout en milieu traditionnel, une source moins chère de protéines de qualité.

## Bibliographie

**Buldgen, A., Detimmerman, F., Sall, B. & Compere, R.** 1992. L'étude des paramètres démographiques et zootechniques de la poule locale du bassin arachidier sénégalais. Rev. Elev. Méd. Pays Trop., 45, 341-347.

**Crawford, R.D.** 1990. Poultry genetic resources: evolution, diversity and conservation. Ed. R.D. Crawford, Amsterdam, Oxford, New-York, Tokyo.

**Doutressole, G.** 1947. L'élevage en Afrique Occidentale Française. Larousse, Paris.

**Horst, P.** 1988. Native fowl as reservoir for genomes and major genes with direct and indirect effects on productive adaptability. Proc. 18th World Poultry Cong. (Nagoya), 99-104.

**Mukherjee, T.K.** 1990. Breeding and selection programs in developing countries. Poultry breeding and genetics. Ed. R.D. Crawford, Amsterdam, Oxford, New-York, Tokyo.

**Nayak, G.** 1994. Performance of between R.I.R and local Phulbani chiken in rural conditions. Int. J. Anim. Sci., 9, 237-238.

# Genetics and breeding of Mediterranean aquaculture species

**Eds: D. Bartley & B. Basurco**
**Proceedings of the Seminar of the CIHEAM Network on Technology of Acquaculture in the Mediterranean (TECAM) jointly organised by CIHEAM and FAO in Zaragoza 28-29 April 1997**
**Cah. Options Méditerr. 1998, Vol. 34**
**CIHEAM , Ctra. Montañana 177, 50059 Zaragoza, Spain**
**ISSN 1022-1379**

Aquaculture is one of the fastest growing food production sectors in many countries of the Mediterranean region. To increase these possibilities, four international networks were established in partnership between FAO and different Mediterranean regional and national institutions. TECAM (Technology of Aquaculture in the Mediterranean) is one of these.

This publication presents the proceedings of a TECAM Seminar and a Workshop held in Zaragoza (Spain) on the April 1997. Both were jointly organized by the CIHEAM-IAMZ and the FAO Fisheries Department.

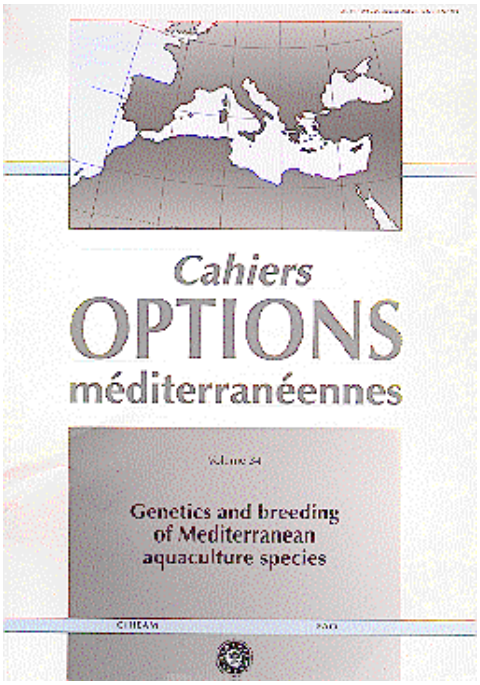
The Proceedings have 21 technical papers covering various aspects of genetics and breeding. Presentations focused on the Mediterranean region, but also included information from other parts of the world and from the agricultural sector in general.

TECAM Network Seminar reviewed the current status of the application of genetics and breeding to the farming of fish and shellfish in the Mediterranean. This critical review then served as a starting point to define future strategies and offer recommendations on the development of aquaculture in the Mediterranean.

The Proceedings published also include the conclusions and a summary of the discussion held at the Workshop. Papers in the Proceedings come under the topics:

- introduction and overview selection;
- selection and crossbreeding in shelifish;
- application of molecular markers;
- chromosome manipulation and transgenesis; and
- biodiversity and conservation.

This publication provides useful information not only to experts directly engaged in the field of genetics and breeding, but also to other interested parties from industry, university or government requiring information on the subject.



## Filière des viandres rouges dans les pays méditerranéens

**Eds: T. Belhadj, J.P. Boutonet & A. di Giulio**
**Actes du séminaire international organisé conjointment par le CIHEAM, l'UE et l'UTAP**
**Tunis (Tunisie) 20-23 avril 1997**
**Séminaires Méditerranéens, Vol. 35**
**CIHEAM , Ctra. Montañana 177, 50059 Zaragoza, Spain**
**ISSN 1016-121-X ; ISBN 2-85352-179-6**

La filière des viandes rouges apparaît, dans la plupart des pays de la région Méditerranéenne, comme un secteur d'activité stratégique. Dans les pays du Sud, la production des viandes rouges repose essentiellement sur l'utilisation des ressources pastorales et fourragères locales, contrairement aux viandes blanches (aviculture) qui dépend, pour près de 90%, de l'importation des produits agricoles pour la fabrication des aliments. Ces pays auront, face aux orientations du libre échange des produits agricoles attendues à l'aube du 21ème siècle, à assurer en même temps trois objectifs: accroître la production des viandes rouges, contrôler les coûts de production et assurer une bonne et constante qualité du produit. Cette tache est d'autant plus difficile que ces pays se trouvent souvent dans des conditions d'aridité, de variabilité climatique et de fragilité des ressources pastorales.

Dans le but d'étudier cette filière et ses perspectives futures, le séminaire international sur "Les viandes rouges dans les pays méditerranéens", organisé du 20 au 23 avril 1997 à Tunis, Tunisie, par le Centre International de Hautes Etudes Agronomiques Méditerranéennes (CIHEAM) en collaboration avec l' Union Tunisien ne de l'Agriculture et de la Pêche (UTAP) et l'appui du Ministère de l'Agriculture Tunisien, a regroupé quatre-vingt-deux participants ayant différents profils (universitaires, chercheurs, développeurs, administrateurs et professionnels) représentant douze pays du Bassin Méditerranéen. Le séminaire a bénéficié d'un appui financier de la Commission Européenne. Le programme du séminaire s'est déroulé en deux étapes, avec une séance plénière avec la présentation d'études de cas et quatre ateliers thématiques ayant porté respectivement sur les aspects de production, d'industrie et de technologie des viandes, la commercialisation d'animaux vivants et de viandes et les organisations professionnelles. Au total, vingt-trois exposés et deux posters ont été présentés et suivis de discussions.

Dans ces Actes figurent ces contributions, ainsi que les Conclusions qui ont été dégagées du Séminaire, tout en constituant dans son ensemble une excellente présentation de la filière des viandes rouges dans la région Méditerranéenne et de ses perspectives d'avenir.

## Guidelines for the management of animal genetic resources

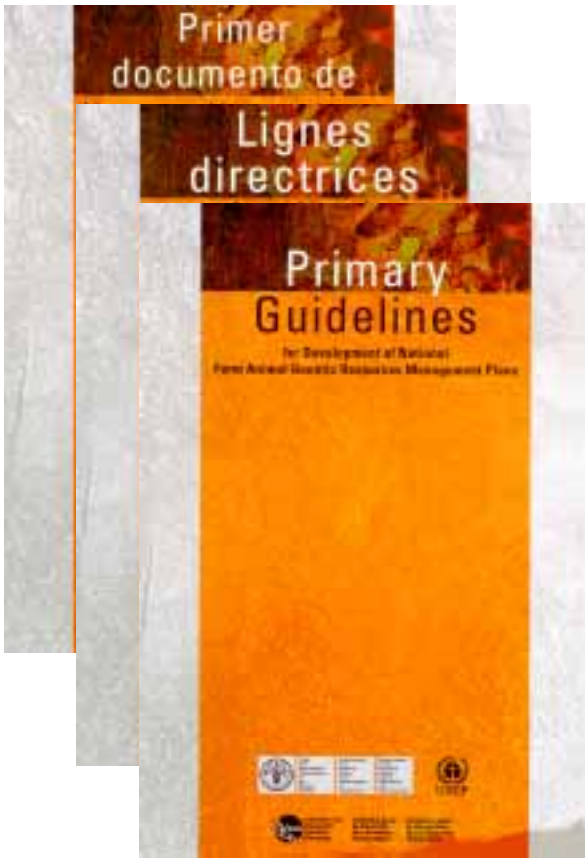
Preparation of national management plans for farm animal genetic resources is a key element of the FAO Global Strategy, as the management of a country's animal genetic resources requires the participation of farmers and breeders, policy-makers, local and indigenous communities, and other stakeholders. A set of Guidelines documentation is being prepared by FAO in a series of step which will eventually lead to realising practical and comprehensive decision aids for use by countries in developing cost-effective activities required for the proper management of genetic resources of all important farm animal species.

Primary Guidelines, which serve as an umbrella document and the first round of the Secondary Guidelines for specific technical areas of the Global Strategy have been recently made available and are listed in the following pages.

### Primary Guidelines for the Development of National Farm Animal Genetic Resources

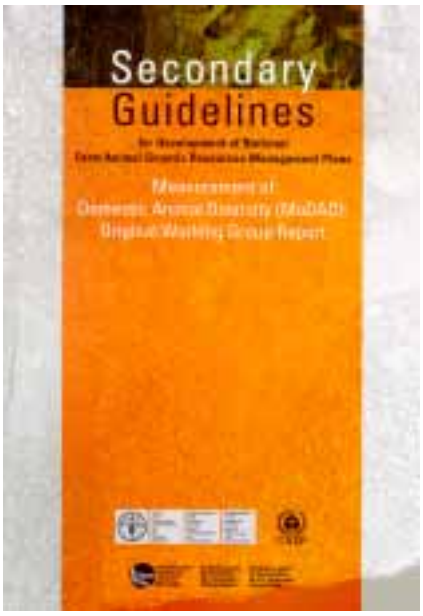
**1998, FAO, pp. 136**
**ISBN 92-5-104164-4**

This documentation can assist countries in establishing their institutional structures required for the management of animal genetic resources and provides an effective means to identify issues and offer options for addressing them. The draft of the Guidelines are available in English, French and Spanish.



## Secondary Guidelines for the Development of National Farm Animal Genetic Resources Management Plans: Measurement of Domestic Animal Diversity (MoDAD): Original Working Group Report

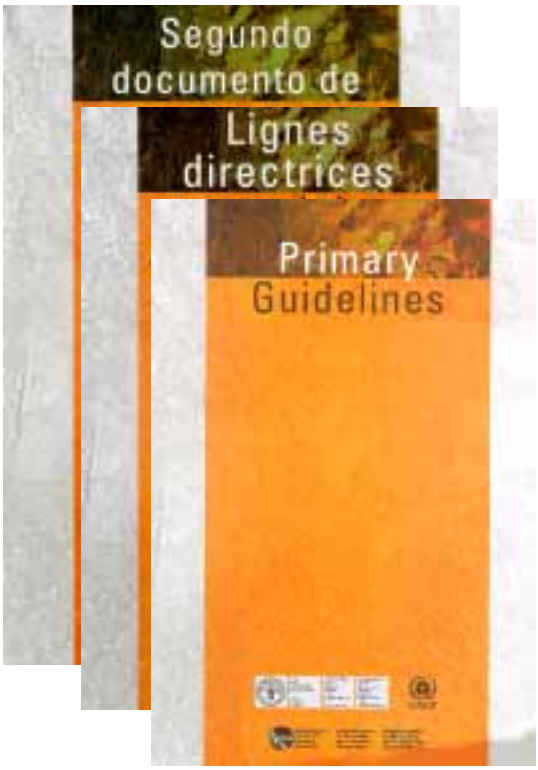
**1998 FAO, pp. 55**
**ISBN 92-5-104166-0**




These Guidelines deal with genetic markers, precision of estimates of genetic distances, sampling, DNA extraction, microsatellite analysis and the establishment of genomebanks.

## Secondary Guidelines for the Development of National Farm Animal Genetic Resources Management Plans: Management of Small Populations at risk

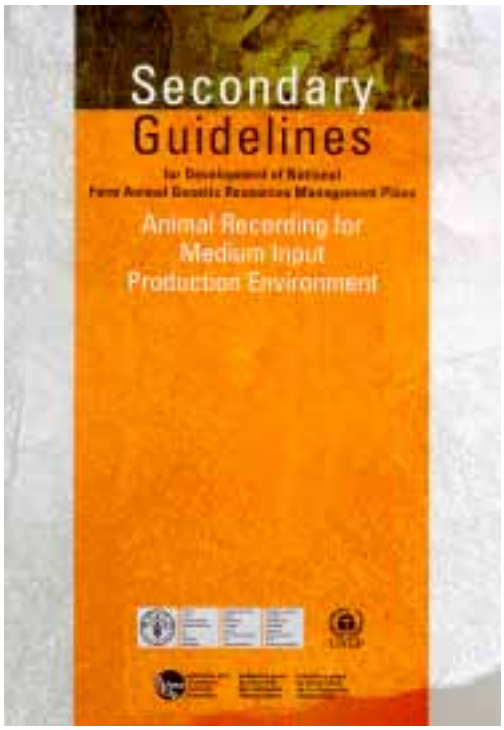
**1998 FAO, pp. 215, ISBN 92-5-104165-2**




These Guidelines offer theoretical and applied principles and procedures for rescuing animal populations at risk of extinction. They deal with the quantitative genetic aspects, design of *in vivo* conservation, cryopreservation and training required. The first edition of the Guidelines is available in English, French and Spanish.

## Secondary Guidelines for the Development of National Farm Animal Genetic Resources Management Plans: Animal Recording for Medium Input Production Environments

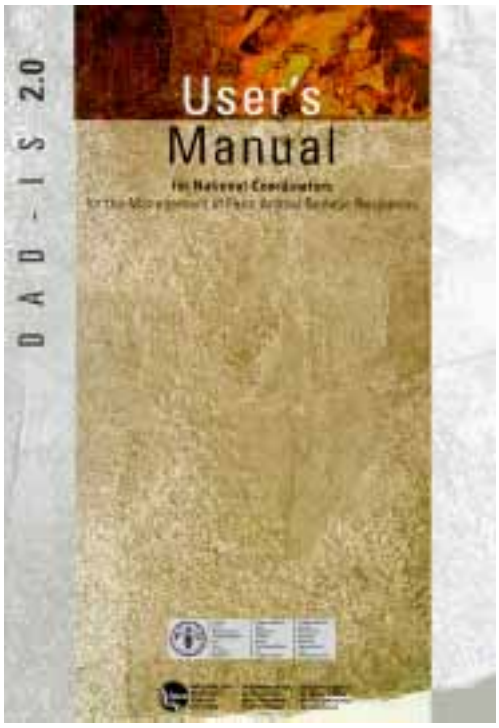
**1998, FAO, pp. 112, ISBN 92-5104167-9**




Animal recording is well developed for high input production systems but not so under lower input systems. This document emphasises the animal recording in the latter. The Guidelines followed on the proceedings of the International Workshop on Animal Recording for Smallholders in Developing Countries jointly organised by the International Committee for Animal Recording (ICAR), FAO and India's National Dairy Development Board (NDDB), which was held in Anand (India) on the 20-23 October 1997 (see AGRI 23, pag. 85).

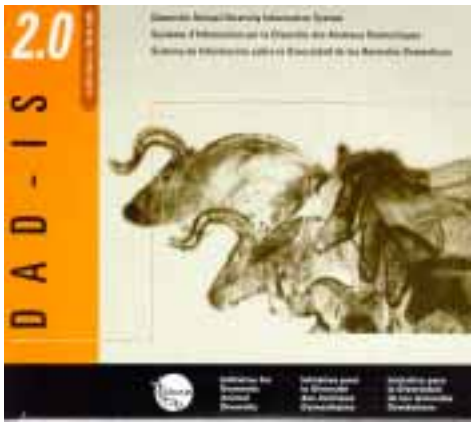
These Guidelines deal with organisational, social, economic, technical aspects in animal recording. They could assist the user in identifying issues relating to specific situation and offer options for action.

## User's Manual for National Coordinators for the Management of Farm Animal Genetic Resources, 1998




While this manual is designed for the primary users of the FAO Domestic Animal Diversity Information System (DAD-IS), the National Coordinators for the Animal Genetic Resources, it also contains information that could be of interest to policy makers, technicians and those who frequent DAD-IS on- or offline often.

## DAD-IS 2.0 CD-ROM




This is an offline version of the updated Domestic Animal Diversity Information System first on the Internet in April 1996. Both the updated online http://www.fao.org/dad-is/ and offline versions were released in September 1998. It includes:

- databases containing population, morphology and performance information on over 4000 breeds of domestic animals in more than 180 countries;
- guidelines and tools for action planning to characterize, develop and conserve domestic animal diversity;
- country-released baseline data on animal genetic resources;
- country, regional and global contacts; and
- briefing on management of animal genetic resources.

The CD is available free from Animal Genetic Resources, AGA, FAO, Viale delle terme di Caracalla, 00100 Rome, Italy.

All the above Guidelines, Manual and CD-ROM are available free from Animal Genetic Resources, AGA, FAO, Viale delle terme di Caracalla, 00100 Rome, Italy. They can also be accessed and downloaded from DAD-IS online http://www.fao.org/dad-is/.

## Sarole danas
## (Charolais today)

**R. Lazarevic, B. Miscevic, S. Aleksic (Eds)**
**Institute for Animal Husbandry Belgrade-Zemun, P.O. Box 23 11080 Zemun, Yogoslavia**
**Tel.:+381-11-691611; Fax: +381-11-670164; E-mail: bramis@sezam.co.yu**
**pp. 166 (In Serbian)**

This booklet first describes the origin and development of Charolais in France, to the present situation with more than 1 500 000 head of cattle.

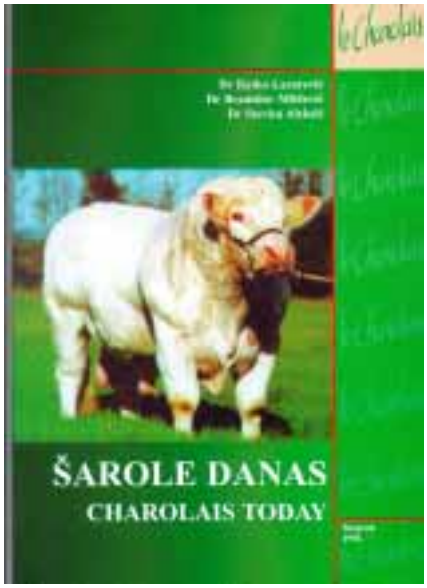
After a brief description of the distribution of this breed in the world, its relevance in the world cattle economy, the authors analyse the three levels of additional information used to select breeding Charolais bulls: A) Individual selection, estimating the animals by its appearance. B) Pedigree selection. C) Progeny selection, judging the productivity of animals, taking into account progeny individual characteristics such as growth, format, carcass quality, maternity traits.

A description of the situation of this breed in USA is then reported, where at the beginning of 1997 there were more than 2 000 000 head of registered and recorded Charolais in the United States.

In this study the authors have paid special attention to breeding Charolais in Slovak Republic, Czech Republic, Hungary, Germany, and Spain. The comparative production results are shown for pure Charolais and crosses between Charolais x Simmental and Charolais x Black and white.

A major part of the booklet refers to Yugoslavia. The bibliography review is far from exhaustive, in particular the many important publications in French of the early 1980s and late 1970s are not listed.

Domestic Spotted cattle of Simmental type and Simmental cattle have an important place in cattle breeding in Yugoslavia. Out of the total number of cattle (1 800 000 head) about 40-50% falls into Simmental type, 30-40% into Domestic Spotted and about 20% into Black and white cattle and other breeds and crosses. The authors analyse the quality, the production, the population size, the distribution and economic relevance of this breed in a Yugoslavian context. A summary of the program for improving Domestic Spotted cattle (30-40% of cattle population) of lower production traits using crossing with French fattening breeds is then described. On the basis of 10 year results it was reported that Charolais x Domestic Spotted crosses gave positive results.



## Cattle breeds: an encyclopedia

**Marleen Felius**
**Elsevier Business Information, P.O. Box 4, 7000 BA Doetinchem, The Netherlands.**
**Tel.: +31-314-343839; fax: +31-314-349871; e-mail r.koopmans@ebi.nl**
**pp. 800**

In this encyclopedia "Cattle Breeds" it is possible to meet more than 1 000 cattle breeds, starting in prehistory and moving to modern times. In this book the Dutch author and illustrator Marleen Felius provides an overview of the world's cattle in words and images. The breeds are classified according to geographical distribution, historical background and external features. There are 800 full colour pages with information from all continents and different eras, showing each cattle breed individually with great attention to detail in the text as well as in the illustrations.

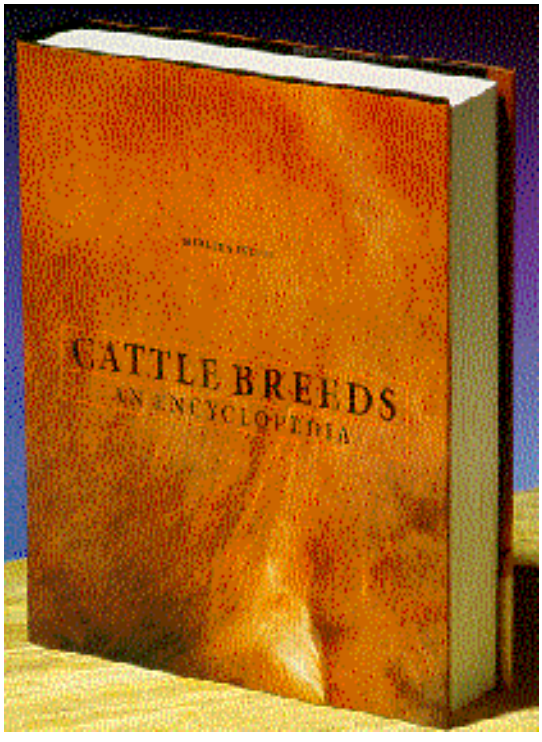
Each main chapter takes the reader on a journey through one continent, following the same clear route everytime. The introduction takes the reader through the historical and commercial background and the master map (divided into subgroups) gives an overview of both the location and distribution of original and derived breeds within and outside of the authentic regions. Then it is possible to meet the original breeds themselves, with highly detailed descriptions and illustrations.

The iconographic approach of the watercolorist has enabled the maintenance of a uniform high standard of illustration throughout the book. The animals have been reproduced to scale, which makes visual comparisons possible. With so much attention given to factual information about the animals, the importance of visualising all the genetically different types of cattle is thus emphasised.

The breeds of domestic cattle are only partially restricted to a particular habitat, and their appearance is not simply a matter of local adaptation, but is influenced by the intervention of man. Breeds are modified to meet human requirement and they are affected by cultural and economic circumstances.

The taxonomic system followed has produced a classification based on three kinds of data: morphological, geographical and historical. Each breed and variety has been carefully assigned its place within this system of Groups and Subgroups, and each is introduced with an account of its systematic relations. The use of charts clearly indicates whether a breed is authentic or is derived from crossbreeding with imported cattle and maps show the areas in which various breeds are found.

Divided in 4 parts (one for each continent), this book contains a valuable list of breeds by country and a deep reference chapter useful for all the people involved in the cattle field.

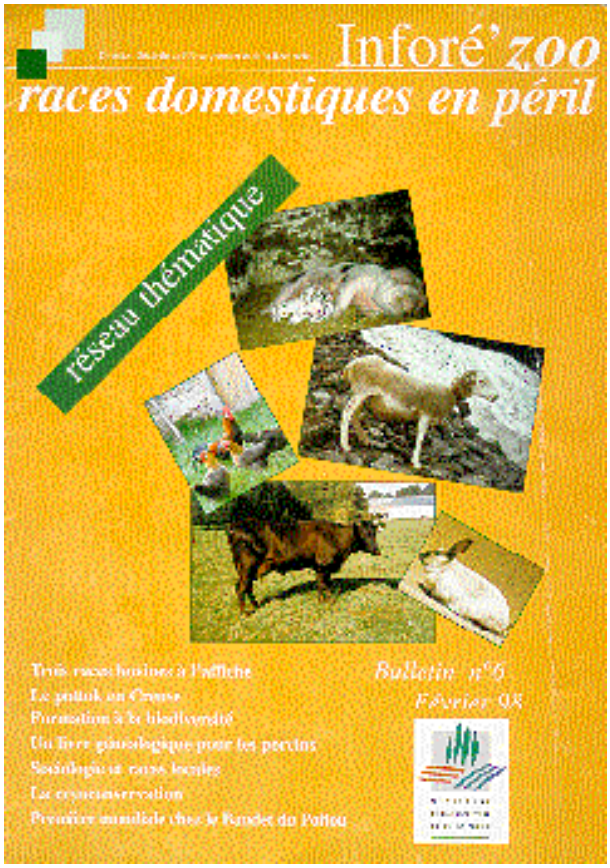


## Inforé' zoo: races domestiques en péril

**Ministère de l'Agriculture et de la Pêche**
**Direction Générale de l'Enseignement et de la Recherche S/D FOPDAC**
**1 ter, Avenue de Lowendal, 75349 Paris 07 SP, Tel.: +33-1-49554955**

Inforé' zoo is a French periodical devoted to animal matters and published by France's Ministry of Agriculture and Fisheries (Network "Races en Péril"). Its 6th issue (February 1998)was devoted to endangered domestic breeds (Races Domestiques en Péril),

It is an informative bulletin on the state of the art of livestock resources endargement and the project of conservation in France. Further information can be obtained from Jean Louis Vergne at the following e-mail address: jean-louis.vergne@educagri.fr.



# 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