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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

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Editorial
Making the Report on the State of the World's Animal Genetic Resources a Success

International stakeholders, national and regional coordinators, professional colleagues in animal genetic resources have worked intensively since last September to put all necessary arrangements in place to make the State of the World's Animal Genetic Resources reporting process a success. Following the intergovernmental working group meeting in FAO in September 2000, the Secretariat and a core team of professionals from all over the world have invested a tremendous amount of time and effort to prepare the documentation and other tools for the necessary man-power training at all levels. In late February 2001, a global training workshop of trainers was organized at FAO Headquarters in Rome, in order to establish a pool of outstanding AnGR professionals to assist countries in the preparation of the country reports, analyze the global situation and prepare the first report on the State of Animal Genetic Resources.

An important milestone was the issuance of the formal letter of invitation to Member Nations and Organizations by the Director-General of FAO. An official "circular state letter" was sent to 180 member nations, one member organization (EU) and some of the non-FAO member nations, such as the Russian Federation, Belorussia, Ukraine and the FR of Yugoslavia. Governments were invited to participate in the preparation of *The State of the World's Animal Genetic Resources*, through an assessment of national animal genetic resources in the form of country reports, using the approved guidelines. As expressed by the Director-General of FAO, reports should constitute an official government document, which will clearly identify national priorities and set out a plan of action for the sustainable utilisation and conservation of farm animal genetic resources. The Commission on Genetic Resources for Food and Agriculture urged that the State of the World on Animal Genetic Resources process be country-driven, which will require the full political, financial and human resources commitment of governments and national stakeholders.

The Director-General of FAO firmly assured member nations that the Secretariat was willing to co-ordinate donor support and assist Member Nations in implementing their national assessment whenever required. The Director-General of FAO also called on participating nations that, the global assessment was to be completed by the established deadline.

As a response to the above mentioned invitation, so far more than 50 member nations confirmed their participation in the preparation of the *First Report on the State of the World's Animal Genetic Resources,* together with details of the official title and address of the designated national authority responsible for co-ordinating the preparatory process in collaboration with FAO.

The Animal Production and Health Division (AGA) of FAO is the Organisation's focal point at the global level for the preparatory process. The Animal Genetic Resources Group of AGA, in close co-operation with national and regional partner institutions and organisations is now preparing the necessary regional training for country-nominated experts who will play key roles in preparing country reports for the State of the World process. Comprehensive training packs and DAD-IS modules have been prepared for this training to assist country stakeholders operationalise the Guidelines. Training workshops are scheduled to take place in Addis Ababa, Ethiopia in July 2001 for participating countries from Eastern and Southern Africa, followed by courses in Brasilia, Brazil (for

South America) in August, in Mexico City (for Central and North American countries), in New Delhi (for India and West Asian countries) in October and so on. Other regional training courses will be held for North European and Baltic sates, as well as south-eastern European countries in Denmark and Hungary respectively, for south-east Asian countries in Bangkok, Thailand, for West-African countries and countries of the South Pacific.

It is well understood that such an important undertaking requires adequate financial support. Therefore FAO is allocating substantial share of its resources from the Regular Programme budget, which needs to be supplemented by extrabudgetary resources. The SoW Secretariat is working closely with countries and organisations, in order to secure funding of the core operation.

It should be underlined that the financial and technical assistance is part of a global initiative to enhance national capacities in order to prepare country reports in animal genetic resources. Funding of activities in the target countries under this project is complementary to similar projects (trust fund support from the Netherlands to West Asia, South America; support from Finland to south-east Europe and East Africa; from France to the European Regional Focal Point of the AnGR co-ordinators network; from the Nordic countries to countries in the Baltic Region; from the United States to the Caribbean etc.). Projects are identified and intended to last six to twelve months and the donor inputs will provide the funding necessary for the training of the AnGR Country Focal Points and for carrying out the preparation for a follow-up project to develop country-based inventories and plans of action. These will include provision for related consultancy services and computer hardware and software for information management and reporting.

Consequently, the direct involvement in the SoW process of the range of international stakeholders is necessary for success. The Second Ad-Hoc Session of International Stakeholders was held in Rome, 5-6 June 2001, to provide further opportunity for stakeholder involvement and support of the SoW-AnGR process

The most important objective of the SoW-AnGR process is to develop national capacities and promote regional and international co-operation for sustainable intensification of livestock production systems at country level. The SoW-AnGR process will enhance the wise use and development of locally adapted animal genetic resources in target counties, whilst taking into consideration the constraints and opportunities of a country's livestock sector driven by growing food demands, changing climate, disease status and technologies.

The SoW-AnGR process is the opportunity to prepare for cost-effective action on better understanding the roles and values of farm animal genetic resources, better using and sustainably developing adapted resources, as well as better conserving and accessing genetic material for future benefit of local communities and the environment. Members of the animal genetic resources professional community should take the lead to develop quality country and regional reports as a strategic policy document and bring AnGR to their right place in food security, sustainable development, while maintaining agricultural biodiversity for beneficiaries today and in the future.

Editorial
Assurer le Succès du Rapport sur la Situation Mondiale des Ressources Génétiques Animales

Les intéressés au niveau international, les coordonateurs nationaux et régionaux, et les collègues du domaine des ressources génétiques animales ont travaillé intensivement depuis le mois de septembre dernier pour que le rapport sur le déroulement de la Situation Mondiale (SM) des Ressources Génétiques Animales soit un succès. Suite à la réunion du groupe de travail inter-gouvernemental qui s'est tenue à la FAO en septembre 2000, le Secrétariat SM et une équipe restreinte de professionnels venant de toutes les parties du monde ont investi une enorme quantité de temps et d'effort pour préparer la documentation et les outils nécessaires à la formation d'experts à tous les niveaux. Vers la fin février 2001 un atelier de formation pour les formateurs a été organisé au Siège de la FAO à Rome pour établir un groupe de professionnels du domaine des Ressources Génétiques Animales qui doivent assister les pays dans la préparation de leurs rapports nationaux, analyser la situation mondiale et préparer le premier rapport sur la Situation des Ressources Génétiques Animales.

Un point déterminant a été l'envoi officiel de la lettre d'invitation aux Etats Membres et aux Organisations intéressées de la part du Directeur Général de la FAO. Une "lettre circulaire aux Etats" a été envoyée à 180 pays, une organisation membre (UE) et certains des pays non membres de la FAO, tels que la Fédération Russe, la Bélorussie, l'Ucraine et l'ex République Yugoslave. Les gouvernements ont été invités à prendre part à la préparation sur la Situation Mondiale des Ressources Génétiques Animales, à travers une enquête nationale sur les ressources génétiques animales et sur présentation d'un rapport national en utilisant les directives approuvées. Tel que l'a exprimé le Directeur Général de la FAO, les rapports devraient constituer un document officiel qui identifiera clairement les priorités nationales et soulignera un plan d'action à suivre pour une meilleure utilisation durable et la conservation des ressources génétiques d'animaux domestiques. La Commission des Ressources Génétiques pour l'Alimentation et l'Agriculture a insisté pour que le processus sur la Situation Mondiale des Ressources Génétiques Animales soit développé dans chaque pays, ce qui implique, de la part des gouvernements et des personnes au niveau national directement intéressées, un compromis total politique et financier ainsi que de ressources humaines.

Le Directeur Général de la FAO a assuré fermement les pays membres que le Secrétariat sera a disposition pour coordonner l'apport des donateurs et pour assister les Etats Membres à mettre en oeuvre leur enquête nationale, si nécessaire. Le Directeur Général de la FAO a aussi fait appel aux pays participants pour que l'enquête mondiale soit menée à terme dans les délais prévus.

En réponse à l'invitation ci-dessus, plus de 50 pays membres ont confirmé leur participation à la préparation du *Premier Rapport sur la Situation Mondiale des Ressources Génétiques Animales*, tout en communiquant les détails relatifs au titre officiel, nom et adresse complète des personnes désignées parmi les authorités responsables au niveau national pour coordonner le processus de préparation en collaboration avec la FAO.

La Division de la Production et de la Santé Animale de la FAO (AGA) est le *Point Focal* de l'Organisation au niveau mondial pour la préparation du processus. Le Groupe de Ressources Génétiques Animales de AGA, en étroite collaboration avec les institutions et organisations partenaires nationales et régionales, prépare en ce moment au niveau régionale la formation des experts només dans chaque pays et qui joueront un rôle important dans la préparation des rapports nationaux sur le processus de la Situation Mondiale. Une série de documents de formation et formulaires DAD-IS ont été préparés pour cette formation afin d'assister les pays intéressés dans la mise en oeuvre des Directives. Des ateliers de

formation ont été programmés pour les pays participants, de l'Est et du Sud de l'Afrique à Addis Abeba, en Ethiopie, en juillet 2001. Ces ateliers seront suivi d'une série de cours à Brasilia (Brésil) au mois d'août, pour l'Amérique du Sud, à Mexico City (Mexique) pour les pays de l'Amérique Centrale et du Nord, puis en Nouvelle Delhi (Inde) au mois d'octobre pour les pays de l'ouest asiatique, etc. D'autres cours de formation au niveau régional se tiendront au Danemark et en Hongrie respectivement, pour les pays de l'Europe du nord et les pays baltiques, ainsi que pour les pays du sud-est de l'Europe. Ensuite, pour les pays du sud-est asiatique à Bangkok (Tahilande), ainsi que d'autres pour les pays de l'Afrique de l'ouest et ceux du Pacific sud.

Il est évident que cette importante initiative demande un soutien financier substantiel. Dans ce sens, la FAO a destiné à cet effet une grande partie de ses ressources provenant du budget du Programme Ordinaire, mais qui devra être augmentée par des ressources extra-budgétaires. Le Secrétariat du SM travaille en étroite collaboration avec les pays et les organisations intéressées afin d'assurer les fonds nécessaires pour la partie centrale de l'opération.

On doit souligner que l'assistance financière et technique est une partie de l'initiative globale qui permet de faire ressortir les capacités nationales afin de pouvoir préparer les rapports nationaux sur les ressources génétiques animales. Le financement des activités dans les pays retenus pour ce projet est complémentaire à d'autres projets similaires (fonds fiduciaire de support des Pays-Bas pour l'Asie de l'ouest et l'Amérique du Sud; soutien de la Finlande aux pays du sud-est de l'Europe et de l'Afrique de l'est; de la France pour le *Point Focal* Régional Européen pour les coordonnateurs du réseau AnGR; des pays du nord européen pour les pays de la région baltique; des Etats-Unis vers la région des Caraïbes). Des projets ont été identifiés et se réfèrent aux derniers six à douze mois et les intrants des donateurs apporteront les fonds nécessaires pour la formation des *points focaux* Nationaux et pour mener à terme la préparation d'un projet de suivi pour développer pour chaque pays des inventaires et des plans d'action. Ceux-ci comprendront aussi les provisions pour les services des consultants impliqués et l'achat d'ordinateurs et de programmes pour la gestion de l'information et l'élaboration des rapports.

En conséquence, l'implication directe dans le processus SM d'un grand nombre d'intéressés au niveau international est nécessaire pour obtenir le succès désiré. La Deuxième Séance *ad-hoc* d'Experts Internationaux dans ce domaine s'est tenue à Rome les 5 et 6 juin 2001 afin de donner une autre occasion d'implication et de soutien de la part des intéressés au processus SM.

L'objectif principal du processus SM-AnGR est de développer des capacités nationales et de promouvoir la coopération régionale et internationale pour une intensification durable des systèmes de production animales dans chaque pays. Le processus SM-AnGR soulignera la large utilisation et le développement des ressources génétiques animales adaptées localement dans des pays déterminés; tout en gardant à l'esprit les contraintes et les opportunités du secteur de production animale au niveau national, poussé par la demande croissante d'aliments, les changements climatiques, l'état sanitaire et l'évolution technologique.

Le processus SM-AnGR représente l'occasion de préparer, à un coût intéressant, une action dans laquelle les rôles et les valeurs des ressources génétiques animales seront plus claires, avec une meilleure utilisation et développement durable des ressources adaptées au milieu, ainsi qu'une meilleure conservation et accès au matériel génétique afin de favoriser dans le futur les communautés locales et l'environnement. Les professionnels chargés des ressources génétiques animales de chaque communauté devraient prendre en main la direction pour développer des rapports nationaux et régionaux de qualité en tant que document de politique stratégique et porter ainsi les ressources génétiques animales à la place qui leur revient vis-à-vis de la sécurité alimentaire et le développement durable, tout en conservant la biodiversité en agriculture, pour les bénéficiaires d'aujourd'hui et de demain.

Editorial
Asegurar el éxito del Informe sobre la Situación Mundial de los Recursos Genéticos Animales

Los interesados a nivel internacional, los coordinadores nacionales y regionales, así como los colegas del sector de los recursos genéticos animales han trabajado de forma intensiva desde el pasado mes de septiembre para que el informe sobre el desarrollo de la Situación Mundial (SM) de los Recursos Genéticos Animales sea un éxito. Tras la reunión del grupo de trabajo inter-gubernamental que tuvo lugar en la FAO en septiembre del 2000, la Secretaría SM y un equipo restringido de profesionales provenientes de todas las partes del mundo, han invertido una cantidad enorme de tiempo y esfuerzo para preparar la documentación y las herramientas necesarias para la formación de expertos a todos los niveles. Hacia finales de febrero del 2001 se organizó en la Sede de la FAO en Roma un taller de formación para extensionistas, con el fin de establecer un grupo de profesionales del sector de los Recursos Genéticos Animales que deberá asistir a los países en la preparación de sus informes nacionales, analizar la situación mundial y preparar el primer informe sobre la Situación de los Recursos Genéticos Animales.

Un punto determinante ha sido el envío oficial de la invitación a los Estados Miembros y a las Organizaciones interesadas por parte del Director General de la FAO. También ha sido envíada a 180 países, a una organización miembro (UE) y a un cierto número de países no miembros de la FAO, tales como la Federación Rusa, Belorusia, Ucraina y la ex República Yugoslava, una "circular a los Estados". Los gobiernos han sido invitados a tomar parte en la preparación de la Situación Mundial de los Recursos Genéticos Animales a través de una encuesta nacional sobre recursos genéticos animales y de la presentación de un informe nacional conforme a las directrices aprobadas. Tal como sugirió el Director General de la FAO, los informes deberían constituir un documento oficial que identificará claramente las prioridades nacionales y subrayará un plan de acción a seguir para una mejor utilización sostenible y conservación de los recursos genéticos de animales domésticos. La Comisión para los Recrusos Genéticos para la Alimentación y la Agricultura ha insistido para que el proceso sobre la Situación Mundial de los Recursos Genéticos Animales sea desarrollado en cada país, lo que conlleva, por parte de los gobiernos y de las personas directamente interesadas a nivel nacional, un compromiso total político y financiero, así como de recursos humanos.

El Director General de la FAO ha asegurado firmemente a los países miembros que la Secretaría estará a disposición para coordinar el aporte de los donantes y para asistir a los Estados Miembros si es necesario en la implementación de su encuesta nacional. El Director General de la FAO también ha hecho un llamamiento a los países participantes para que la encuesta mundial quede concluida en los tiempos previstos.

En respuesta a la invitación mencionada anteriormente, más de 50 países miembros han confirmado su participación a la preparación del *Primer Informe sobre la Situación Mundial de los Recursos Genéticos Animales*, comunicando asimismo los detalles relativos a títulos oficiales, nombres y direcciones completas de las personas nombradas entre las autoridades responsables a nivel nacional para coordinar el proceso de preparación en colaboración con la FAO.

La División de Producción e Higiene Animal de la FAO (AGA) es el *Punto Focal* de la Organización a nivel mundial en la preparación de dicho proceso. El Grupo de Recursos Genéticos Animales de AGA, en estrecha colaboración con las instituciones y organizaciones asociadas nacionales y regionales, prepara en estos momentos a nivel regional la formación de los expertos nombrados en cada país que jugaran luego un papel importante en la preparación de los informes nacionales sobre el proceso de la Situación Mundial. Una serie de documentos de

formación y formularios DAD-IS han sido preparados en vistas de esta formación con el fin de asistir a los países interesados en la implementación de las Directrices. Ha sido programado un taller de formación para los países participantes del Este y Sur de Africa en Adis Abeba, Etiopia, en julio 2001. A este taller seguirán una serie de cursos en Brasilia (Brasil) en el mes de agosto, para América del Sur; en Ciudad de Méjico (México) para los países de América Central y del Norte; luego en Nueva Delhi (India) en el mes de octubre para los países del Oeste asiático, etc. Otros cursos de formación a nivel regional vendrán organizados en Dinamarca y en Hungría respectivamente, para los países del Norte de Europa y Bálticos, así como para los países del Sur Este de Europa. Más adelante, se organizarán para los países del Sur Este asiático en Bangkok (Tailandia), y otros países del Oeste africano y del Sur del Pacífico.

Es evidente que esta importante iniciativa necesita de un aporte financiario consistente. En este sentido, la FAO ha destinado para ello una parte substancial de sus recursos provenientes del presupuesto del Programa Ordinario, pero este monto deberá ser aumentado con recursos extra presupuestarios. La Secretaría de la SM trabaja en estrecha colaboración con los países y las organizaciones interesadas con el fin de asegurar los fondos necesarios para cubrir la parte central de la operación.

Se debe subrayar que la asistencia financiera y técnica es parte de la iniciativa global que permitirá resaltar las capacidades nacionales y preparar los informes nacionales sobre los recursos genéticos animales. El financiamiento de las actividades en los países seleccionados para este proyecto es complementario al de otros proyectos similares (fondos de fideicomiso de apoyo de los Países Bajos para el Oeste de Asia y América del Sur; apoyo de Finlandia a los países del Sur-Este de Europa y del Este de Africa; de Francia para el *punto focal* Regional Europeo para los coordinadores de la red AnGR; de los países del Norte de Europa hacia los países de la región del Báltico; de Estados Unidos hacia la región del Caribe). En los seis a doce últimos meses se han identificado proyectos y los aportes de los donantes servirán para cubrir los fondos necesarios para la formación de *Puntos Focales* Nacionales y para llevar a cabo la preparación de un proyecto de seguimiento para desarrollar en cada país los inventarios y los planes de acción oportunos. Estos incluirán también las provisiones para los servicios de los expertos implicados y para la compra de ordenadores y programas para la gestión de la información y la elaboración de los informes.

Por consiguiente, la implicación directa en el proceso SM de un gran número de interesados a nivel nacional es necesaria para alcanzar el éxito deseado. La Segunda Session *ad-hoc* de Expertos Internacionales en este sector tuvo lugar en Roma el 5 y 6 junio 2001 con el fin de proporcionar otra ocasión para una mayor implicación y apoyo por parte de los interesados en el proceso SM.

El objetivo principal del proceso SM-AnGR es desarrollar las capacidades nacionales y promover la cooperación regional e internacional para una intensificación sostenible de los sistemas de producción animal en cada país. El proceso SM-AnGR resaltará la amplia utilización y el desarrollo de los recursos genéticos animales adaptados localmente en ciertos países; teniendo en cuenta siempre las limitaciones y oportunidades del sector de la producción animal a nivel nacional que se encuentra sujeto a la demanda creciente de alimentos, a los cambios climáticos y a la situación sanitaria y la evolución tecnológica.

El proceso SM-AnGR representa la ocasión de preparar, a un costo interesante, una acción en la que el papel y el valor de los recursos genéticos animales sean más claros, con una mejor utilización y desarrollo sostenible de los recursos adaptados al ambiente, así como una mejor conservación y acceso al material genético con el fin de favorecer en el futuro las comunidades locales y el ambiente. Los profesionales encargados de los recursos genéticos animales de cada comunidad deberían tomar en mano la dirección para el desarrollo de informes nacionales y regionales de calidad, como documento de política estratégica, y llevar así los recursos genéticos animales al lugar que les corresponde en relación con la seguridad alimentaria y el desarrollo sostenible, conservado al mismo tiempo la biodiversidad en la agricultura para beneficio de hoy y mañana.

Why should we become involved in the State of the World of Animal Genetic Resources process? A view from Asia

P.N. Bhat

World Buffalo Trust, Flat No.205, No.F64-C/9, Sector 40, ***Noida****, Gautam Budh Nagar, UP 201 303, India*

Biological diversity is the vital organic resource on which the present and future sustenance of humankind depends. The farm animal genetic resource (AnGR) sector of this diversity provides the variety and variability of species, breeds and populations including unique genotypes which underpin an essential component of food and agriculture production. Judicious use and enhancement of these living resources must be ensured, also with their conservation, so that we may meet the increasing demands for food.

The Asian sub-continent is one of the world's mega biodiversity centres. It was in this region that domestication of flora and fauna was carried out in ancient times. With respect to domesticated mammals and birds, ranges of species encountered are astounding. From Vedic to British times, the improvement in livestock has been made in response to community utilities, which have changed from time to time. In cattle for example, the primary thrust in Europe has been on bullock power as opposed to horsepower. The main emphasis was on the development of breeds, which produced the most effective motive power for agricultural operations.

Now, the relative importance of animal energy has considerably decreased, due to mechanization in agriculture. Bullocks, within the next 50 years, will be phased out from the agricultural operations, even from small holders' farms, effecting a major shift in the utilities of bullocks, the backbone of a traditional system for almost 5000 years. Our development objectives for cattle are to be redefined. India has a bovine population of about 200 million, far too many than required for a pulsating and vibrant milk economy. Technological challenges, e.g. cross-breeding *versus* selection within local breeds, total replacement of populations *versus* a balance of stable mixes in context with the environment of performance, relative cost of producing animal products and shifts between peri-urban and rural production, need new thinking and policy shifts.

The management requirements and demands for animal foods and ways to meet these with the human population growth of 1-2 percent per annum and technologies available, need to be taken into consideration when developing new strategies and frameworks, practical policies and decisions to move forward.

There are groups of countries which have common resources, (Zebu cattle, buffaloes, tropical sheep and goats), production systems and interdependence of institutions. In this context, there is a need to look at the problems regionally so that resources in people and material are put to the best use.

It would be desirable for each of the countries involved to concentrate on what they have in terms of animal genetic resources, their strengths and weaknesses, what are they likely to do with them and how they propose to handle these resources so that wealth and food security is assured.

If for example, the nations want to alleviate poverty and convert small and marginal livestock holders into livestock entrepreneurs to increase their production of food from the present 20 to 40 percent in the next 25 years, they will need to assess and analyze the available AnGR and based on this assessment, develop strategies for wealth and employment generation. FAO's State of the

World Process for AnGR is a most important opportunity to develop an effective country strategy, with realistic priorities and needs to be firmly identified for each of its elements and to become part of the global action plan.

The reasons for most countries becoming involved in the State of the World of Animal Genetic Resources (SoW-AnGR) process are two-fold. The primary interest in most countries in South and South-Eastern Asia is to make an objective assessment of the kind of resources which exist in each country and throughout the region. It will be necessary for them to assess food requirement and plan to produce food sustainability within the available ecosystems. It will assist in countries evaluating the kind of breeding strategies introduced over the past 50 years. If we examine one particular aspect for cattle, we will broadly notice that breeds of temperate origin were inducted for introducing high milk yield and fast growth in the indigenous locally adapted cattle, without bringing in the technology used in developed countries to sustain high milk production in these inducted breeds. Consequently, although these crossbreds did well under enhanced inputs, they were unable to produce due to poor sustainability of the production system and were invariably reduced to mongrels. It would have been more correct in the first place before these introductions were made, for the country to have comparatively evaluated various parameters of the indigenous and temperate cattle and made careful analysis and judgement of the strengths, weaknesses, opportunities and threats caused by these high producing temperate new breeds when directly compared to local breeds in the perspective of initial and perhaps on-going cross-breeding as a technology input.

It is therefore necessary, that each of us should become seriously involved in producing a State of the World report for the country, thus allowing countries to clarify these issues and develop the priorities in a strategic manner and to provide clear directions for action. A cadre of global level expertise is being developed to train and assist countries in the development of their State of the World report. It would also be necessary to take action to train a cadre within the country and provide direct assistance for development of a highly effective country report with the assistance of a package of tools developed by FAO so that the country system can be efficiently built up.

Objectives of the Sow-AnGR Process

The basic purpose of the SoW–AnGR process is essentially to assist countries to substantially improve understanding, use, improvement as well as conservation of their AnGR and to develop a common structure across the countries for the country reports which will identify priorities and analyze information on the state of management of AnGR. To develop coherence to the common structure, it is necessary to develop basic formats which can cover major issues which need to be addressed. This is the first requirement which has been undertaken and completed with satisfaction by FAO Headquarters, with substantial input from country expertise of all regions of the world. The global cadre of expertise developed by FAO will support the SoW-AnGR process to:

1) conduct regional training workshops for key country operatives, and
2) provide for direct in-country assistance in the development of a country report.

For this, it is necessary that uniform training materials be developed. These materials have also been drafted and will be tested at regional training workshops.

At the global and country levels it is important that the necessary additional funds be provided, to complement the substantial inputs by FAO and to ensure the success of the country-driven SoW-AnGR Process. Let us hope that major international collaborators will also want this important SoW-AnGR activity for the livestock sector globally and will also want to help to ensure its success and contribute to the international

stakeholders and donors mechanism which FAO is further developing to facilitate the SoW-AnGR work.

At country level, the process has suggested a number of enabling activities recommended by FAO to progress the capacity building and country report developments are strongly supported. Following government acceptance of the FAO Director-General's invitation to participate in the SoW-AnGR Process, it is firmly recommended that the government establish a balanced working group and a national consultative committee (NCC), which is capable of being highly effective and which begins work immediately, with terms of reference for developing in a step-by-step approach the entire country report following the plan of action chalked out and accepted globally. The NCC's work to frame the country report is recommended to begin immediately, whilst action is also beginning in parallel on the in-country training, network development and involvement of stakeholders, support data gathering, mobilization of funds and special budget to follow up steps of preparing the various elements of the country report.

Initiation of Activities at FAO

In the mid-nineties a major decision was taken by the FAO Council of Country Membership to prepare a Global Strategy for AnGR management. This was followed by meetings of a panel of experts and the regionally-balanced Intergovernmental Technical Working Group on AnGR (ITWG-AnGR) which is developing the framework for the Global Strategy. As a further step and within the Global Strategy framework the ITWG-AnGR developed the guidelines for country use in preparing the SoW-AnGR. In addition, FAO has developed an informatics package called Domestic Animal Diversity Information System (DAD-IS) which is a unique system of tools which can be used by each country to gather and store, retrieve information on AnGR in electronic format, to use in further developing the Country Network for AnGR and for developing and delivering the SoW-AnGR Country Report as a strategic policy document. The ITWG-AnGR recommended that the SoW-AnGR Process should be consultative and cost-effective and it is impressive to learn of the efforts being made by FAO to realize consultation and cost-effectiveness.

It is also obvious that this country-driven SoW-AnGR Process has outstanding potential to build up the so badly needed additional country capacity in policy, technical and operational aspects required for effective AnGR management - *the lack of understanding, poor use and development and very poor conservation action on these irreplaceable resources cannot be permitted to continue if we are to realize sustainable food security for all!*

The Global Strategy

Presently, farm AnGR accounts for 30-40 percent of total agricultural outputs. There is an increasing demand in animal products fuelled by population growth, urbanization and a rise in income, also intensification and industrialization of livestock production systems with uniform breeds. In developed countries with high availability of all production inputs, concentration is on high input/high output breeds and replacement of locally adapted breeds. While in the developing world traditional production systems are transforming and the use of exotic breeds is promoted leading to dilution or loss of locally adapted breeds. Environmental stress factors will however, remain in most parts of the world for the medium-term future. There is a need for farmers to have access to a diversified gene pool and to all available knowledge and technology, only global action can make this possible.

The Convention of Biological Diversity (CBD) came into force in 1993 and 170 Member Governments of FAO accepted in 1995 the further development of the Global Strategy, to provide a framework for use in establishing effective national, regional and global policies, strategies and actions. It was

decided that FAO would facilitate and coordinate the activities of organizations interested in AnGR within sustainable agriculture and rural development and assist countries in developing the capacity to manage AnGR through planning, designing and implementing sustainable livestock production systems and promoting the establishment of cost-effective approaches for conserving AnGR.

This was to be driven through the institution of a Global Focal Point (GFP) at FAO Headquarters in Rome and Regional Focal Points (RFP) at the regional level throughout the world to help ensure that countries of the region are well supported in establishing sustainable programmes of action within country and regionally and to best utilize the region's capacity. The responsibility of GFP is to develop the framework for the Global Strategy and to detail the constituent parts of this framework, for country use, a country-based global infrastructure, including regional and national focal points and the DAD-IS, a technical programme of work developing guidelines for sound management of AnGR and an early warning and early reaction system, a reporting, progress evaluation and priority action development component, including the SoW-AnGR Process and an intergovernmental mechanism to review and guide the Strategy's development and to serve as a forum for harmonizing country policy and as necessary to develop an international policy for AnGR.

The FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) with advice from its ITWG-AnGR, coordinates policy and sectoral matters related to sustainable use and conservation of AnGR. It is important in terms of driving the SoW-AnGR Process that this be guided by this important global Commission and that the Commission debate the acceptance in 2003 of the Strategic Priority Actions Report and in 2005, the first full Report on the SoW-AnGR. These two major reports will be drafted by the FAO Secretariat using the Country Reports on the Sow-AnGR. Therefore, *countries can expect to benefit substantially within-country and internationally by agreeing to be directly involved in the SoW-AnGR from the outset!*

National and state governments would implement national policy and strategies for sustainable development and conservation of AnGR enabled by the country reporting process and also draft such legal instruments identified as required. While GFP would lead planning, development and implementation of the Global Strategy, international policy development, development and maintenance of DAD-IS and AnGR management guidelines and decision-support tools for country use, assist with mobilizing donor resources, etc., the RFP would facilitate communication, initiate development of regional policy, assist in identification of priorities and interact with government, donors and NGOs.

National Focal Points (NFP) would coordinate country activities, identify capacity building needs of the country network, assist development and implementation of policy and interface with stakeholders, RFP and GFP. It is also ensured that the donor and stakeholder involvement mechanism, provides a means for donors and stakeholders to have opportunities to influence design and implementation of regional and global work.

DAD-IS

DAD-IS provides countries with advanced communication and information tools, country secure storage and communication of AnGR data and information, it is the basis for early warning and is a reaction system for AnGR. This will help countries prepare their national management plans for AnGR, characterize their breeds and production systems and advance AnGR sustainable use and development.

The DAD-IS SoW-AnGR module has been developed to support the in-country preparatory process. It has eight elements. The SoW Manager assists in the building of the National Consultative Committee, the Country Network. The SoW data enables

countries to develop their National SoW-AnGR Databank for on-going use in planning, the reviewing progress and action. The SoW Report assists the NCC in methodically stepping through the development of a strong country report on strategic policy for AnGR management. Each of the eight elements has specific operational tasks which function on three distinct levels, the NCC, national coordination and the supporting data contributor, all of whom contribute to the development of the appropriate preparation of the country report.

Country Report

The country report should be a strategic policy document which gives the country an opportunity to create a vision and strategic plan for better management of AnGR on:

1) where are we in terms of management of AnGR?
2) where do we want to be? and
3) how do we get to where we want to be?

Its objectives are to establish essential baseline data and information on the status of animal genetic diversity in the country, to assess roles and values of local and introduced breeds and the impacts of traditional agricultural systems on AnGR. It should include improved understanding of the status of breeds that are currently not of value to farmers and of wild relatives of domesticated animals, the capacities of public and private institutions and farmers and tribal communities in the management of AnGR. It should also examine the methodologies being used, to understand the value of AnGR, to better use, develop and conserve them in a sustainable manner.

Once the national priorities are identified for action on sustainable conservation and utilization of AnGR, requirements in international or regional cooperation in germplasm exchange and management can also be stated such that networking of stakeholders (NGOs, farmers' group, breeders' association, etc.) can be developed to increase awareness of the many roles and values of AnGR, promoting their better utilization, development and conservation, enhancing existing networking between countries with shared or common AnGR and/or common production systems or issues and promoting communication and collaboration within and between networks and among government and NGOs involved in the management of AnGR.

Once the Country Report is prepared, its importance becomes clear as it becomes the basic document for use in establishing an effective short-, medium- and long-term plan for development of AnGR and to commit national resources. It will also identify main directions for future national policies and programmes, determine priorities for action for government and stakeholders, identify emerging issues directly related to the management of AnGR in relation to animal welfare, animal health and impact on the environment, etc. It will assist farmers, indigenous and local communities in the identification of AnGR that can increase production, productivity and product quality.

It will enhance the capacity to both manage and report on AnGR through improved communication and organization capacity and identify situations where an emergency response could be required to prevent the loss of AnGR.

The country report will in addition to the AnGR themselves, also take into consideration:

1) agricultural biodiversity;
2) production systems and environments in which AnGR are used;
3) range of animal products and services which they provide;
4) consumption patterns and socio-cultural practices associated;
5) ecosystems functions which they sustain; and
6) their role in the agricultural production and food security of the country.

The range of activities to be addressed in the report should include:

1) *in-situ* and *ex-situ* conservation;
2) characterization; and
3) use and development.

Regional Coordination

Regions with common problems in terms of common assets, breeds and species will need to develop a regional approach to problem solving. A regional report or plan of action should be prepared which will take into account the inter-dependence between the countries to optimally utilize their resources and provide a framework for coordination of regional activities and collaboration and develop a regional constituency for conservation and sustainable use of AnGR.

Coordination mechanisms should facilitate communication, information sharing, networking and collaboration, facilitate sharing of technical expertise and resources amongst countries, capacity sharing and initiate cross-cutting activities such as facilitating development of regional policies.

It would be highly desirable that collaboration amongst the involved countries identifies regional priorities for implementation, mobilizes support and resources for regional and country activities, assists development of regional information for the SoW-AnGR process and commits support and directs the countries involved.

It is therefore, in the interest of each country, regardless of its status or the capacity in manpower to quickly get involved in this SoW-AnGR process and be a partner in the building of a better world. The animal genetic resources group at FAO has developed a vision for a new world where they have taken into account everyone's needs and plans accordingly. We will all share in this vision.

Caracterización de los animales domésticos en España

J.V. Delgado[1], C. Barba[1], M.E. Camacho[2], F.T.P.S. Sereno[1], A. Martínez[1] & J.L. Vega-Pla[3]

[1]Unidad de veterinaria, Departamento de Genética, Universidad de Córdoba, Av. Medina Azahara, 9, 14005 ***Córdoba*** *España*
[2]Laboratorio de Sanidad y Producción Animal, Consejería de Agricultura, Junta de Andalucía, Carretera Córdoba-Alcolea, ***Córdoba****, España*
[3]Laboratorio de Grupos Sanguíneos, Apartado Oficial Sucursal 2, 14071 ***Córdoba****, España*

Resumen

La expansión actual de los criterios conservacionistas han promovido la utilización de las modernas metodologías que brinda la genética molecular para la caracterización de las razas, aunque la caracterización genética clásica basada en marcadores bioquímicos e inmunogenéticos se ha aplicado durante muchos años sobre todo en rumiantes y equinos en pruebas de identidad y control de filiación. El estudio del polimorfismo de los microsatélites del ADN han ofrecido muy buenos resultados, aunque también se ha trabajado con éxito en la investigación del ADN mitocondrial y de fragmentos de ADN amplificados aleatoriamente. En España estos métodos han sido utilizados en las especies bovina, ovina, caprina, porcina, equina y canina.

De cualquier forma, es importante considerar que la obtención de perfiles genéticos poblacionales para los caracteres morfológicos y productivos, es obligada en una aplicación práctica de los resultados obtenidos con los marcadores genéticos. En el presente trabajo se describen las principales iniciativas desarrolladas en los aspectos mencionados, ubicando los equipos españoles especializados.

Summary

The present expansion of the conservationism has stimulated the use of the modern methodologies based on the molecular genetics for the breed characterization. Characterization based on biochemical and immunogenetics markers has been used intensely, especially in ruminants and equines for identification and paternity control. Microsatellites of DNA have given very good results as has the study of the mitochondrial DNA and random amplified polymorphism of DNA. In Spain these methods have been used in cattle, sheep, goats, equines and dogs.

It is important to consider that the investigation on population genetic profiles of morphological and productive characters is necessary to apply the results obtained from the genetic markers.

This paper describes the principal Spanish initiatives in the above-mentioned subject, the Spanish teams specialized in these types of research.

Key words*: Genetic resources, Conservationism, Genetic markers, Polymorphism.*

Introducción

Hasta mediados del presente siglo no se alcanzó en España una implantación total de los criterios zootécnicos modernos basados en la gestión genética de poblaciones cerradas,

con fines de cría en pureza o bien con destino al cruzamiento. Estos criterios nacieron con Bakewell en Inglaterra durante el siglo XVIII y fueron impulsados por ilustres genetistas como Lush ya en épocas más recientes, cuando se contó con los fundamentos de genética cuantitativa necesarios para dotar de contenido los métodos intuitivos de los grandes zootecnistas del XVIII.

Por tanto, la unidad de trabajo en la zootecnia actual es la raza, o bien otras estructuras intraraciales de menor rango genético como son la variedad, la estirpe o la línea. Por esta razón es imprescindible conocer los límites que definen a las mismas con respecto al resto de unidades de su mismo nivel, es decir, una línea frente a otras líneas de la misma raza, o una raza frente al resto de razas de la misma especie. Esa es la razón por la cual la caracterización de estas estructuras biológicas tan vital importancia dentro de la Producción Animal, al menos en los países desarrollados.

Hoy en día aparte de la importancia de fundamento mencionada anteriormente, surgen otras de tipo aplicativo y comercial, como es el caso de la necesidad de definir los productos catalogados dentro de las marcas de calidad y denominaciones de origen de los alimentos. También la efervescencia de los nacionalismos está induciendo a los distintos pueblos que forman el viejo continente a reclamar las razas como un patrimonio cultural, y por ello, demandan su total definición frente a las razas de otros pueblos. Ambos apuntes tienen una especial relevancia en la España del siglo XXI.

Asimismo es de destacar la presión a la que se asiste en el ámbito mundial a favor de la conservación de los recursos genéticos con vistas a su utilización racional y al reparto justo de los beneficios por ellos producido. Especialmente, después de la cumbre de Río de Janeiro, estos conceptos se han introducido en las legislaciones de muchos países, y por supuesto en la Unión Europea y consecuentemente en España.

Lo descrito nos sitúa en un presente donde el concepto de raza está totalmente asumido, como base de trabajo en Producción Animal, y como reservorio de la variabilidad genética de las especies, pero en España esto no siempre fue así. En nuestro país, desde los años 20 se creó una corriente de importantes etnólogos que estudiaron y divulgaron las características de las razas españolas. Entre ellos destacaron D. Rafael Castejón y D. Gumersindo Aparicio. Esta base teórica creo escuela prolongándose hasta la actualidad con insignes figuras de esta disciplina como los Dres. Sánchez Belda, Tejón, Aparicio Macarro, Sierra, Herrera y Sotillo, todos ellos continuadores en la descripción fenotípica de las razas españolas, esfuerzo que se ha visto plasmado en múltiples publicaciones de relevancia (Sánchez Belda y col. 1974, 1981, 1984, 1986; Tejón. 1986; Herrera y col. 1986, 1988, 1990; Herrera y col., 1988, 1991).

Más recientemente la encomiable labor de los etnólogos se vio apoyada por los genetistas que se incorporaron al estudio de las razas dotándolo de nuevas perspectivas, fundamentalmente basadas en la búsqueda del perfil genético de las poblaciones (razas, variedades, estirpes o líneas). La incorporación de los genetistas, que acontece en los años setenta, supuso un cisma en el que resultaron dos corrientes. La "etnoexcéptica" anidada en las escuelas de Agronomía, en la que se interpretaba a la raza como un artificio que no se correspondía con una realidad biología como era el propio concepto de especies. Y otra corriente defensora de las razas como unidad fundamental de la zootecnia, asentada esta vez en las Facultades de Veterinaria. En este caso, se observaba a las razas como una realidad biológica dotada de algunos fundamentos antropológicos, como es la fijación de sus características en un patrón racial, su delimitación en el seno de un libro genealógico y su gestión por parte de una asociación de criadores.

En la actualidad el etnoexcepticismo ha desaparecido ante el indiscutible reconocimiento internacional de las razas apoyado por estructuras como la Federación Europea de Zootecnia (EAAP) y la Organización para la Alimentación y la Agricultura (FAO).

Una vez que admitimos la existencia de razas, no sólo desde el punto de vista etnológico, sino también desde la óptica genética, el primer y más importante paso es la caracterización de las mismas, ya que esta información nos permite establecer el patrón racial, sobre el que se desarrollara el reconocimiento oficial de las razas plasmado en las normas gestoras de su libro genealógico; y por supuesto, ofrecerá una base para el trabajo de las asociaciones específicas de las razas.

Caracterización de las Razas en España

En este epígrafe haremos una breve descripción de la metodología de trabajo que se sigue en España para la caracterización de nuestras razas.

La caracterización se consigue a través de la obtención del perfil genético de la población (Figura 1), para ello se trabaja en tres vertientes, dos de ellas comunes con los trabajos desarrollados a este respecto en el mundo salvaje y una tercera exclusiva de los animales domésticos. Las dos primeras serían la caracterización morfológica y la caracterización basada en marcadores genéticos. La tercera, al tratarse de animales de renta sería la caracterización productiva y reproductiva.

La caracterización morfológica se basa la obtención de los valores promedio poblacionales para una serie de caracteres externos de naturaleza cuantitativa (peso, alzadas, perímetros y diámetros) bien a través de la medición de todos los animales de la población, cuando esto es posible, o bien desde una muestra estadísticamente representativa. También se realizan recuentos de las frecuencias de aparición de distintas variantes de caracteres exteriores de naturaleza cualitativa (color de la capa, forma de cuerno, perfil cefálico, etc.).

La caracterización basada en marcadores genéticos utiliza características genéticas estructurales de naturaleza cualitativa de nulo o escaso interés productivo, detectables mediante análisis laboratoriales más o menos complejos. En este caso se buscan expresiones genéticas directas en forma de proteínas como los polimorfismos bioquímicos (Figura 2), el funcionamiento de la bomba de sodio y potasio, o formas antigénicas ligadas a los hematies (grupos sanguíneos) o a los leucocitos y resto de células somáticas (sistema mayor de histocompatibilidad). Y más recientemente se utilizan los avances de la genética molecular para detectar variaciones en regiones hipervariables del ADN, siendo los más usados hoy en día los microsatélites (Figura 3). En esta faceta de la caracterización genética de las razas profundizaremos en un epígrafe posterior.

Finalmente, tenemos la caracterización productiva, que de manera similar a la descrita para los caracteres morfológicos, se basa en la obtención de valores promedio raciales para distintas variables de interés económico que se expresan en los animales de renta, variables cuantitativas que casi siempre tienen naturaleza continua, pero en ocasiones aparecen como discontinuas. En este caso y según la especialización de la raza en concreto, medimos caracteres lácteos (cantidad y composición de la leche), cárnicos ligados a la productividad individual (pesos y crecimientos a distintas edades) y a la productividad numérica (prolificidad y tamaño de la camada al destete), y en otra funcionalidad caracteres laneros, peleteros, hueveros e incluso comportamentales y deportivas (perros, toro de lidia, caballos).

Cuando observamos la expresión individual en cada animal de los caracteres morfológicos y productivos, se trata de expresiones fenotípicas fuertemente influidas por los efectos ambientales, que me imposibilitan la definición genética de ese individuo. Pero cuando se accede al valor promedio del carácter en la población, bien a través de la medición de toda ella, o bien a través de un muestreo estadísticamente adecuado, la expresión poblacional del carácter cuantitativo se trasforma en una expresión directa del genotipo medio de la población, ya que las desviaciones ambientales en sentido positivo y negativo se han neutralizado entre sí. Por tanto, la

Caracterización genética de los animales domésticos en españa

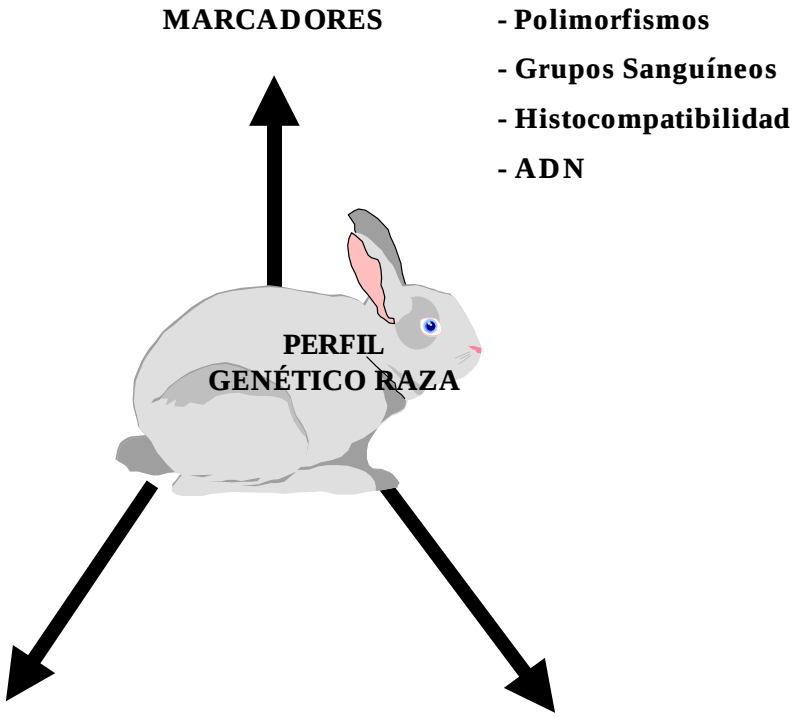

Figura 1. Esquema general de caracterización genética.

caracterización morfológica y productiva es una caracterización genética de la población basada en caracteres de naturaleza cuantitativa y por tanto poligénica. Hacemos esta aclaración ya que con frecuencia se entiende como caracterización genética sólo a aquella basada en marcadores genéticos, mientras que en realidad toda aproximación al genotipo medio de la población nos es de utilidad en la definición de las poblaciones (razas, variedades, estirpes o líneas).

El procedimiento que se sigue en la caracterización morfológica y productiva se puede resumir en el siguiente protocolo (Herrera y col., 1996; Capote y col, 1998; Delgado y col., 1998 y 2000; y Barba, 1999):

- Diseño del muestreo y plan de mediciones.
- Creación de bases de datos
- Calculo de estadísticos descriptivos
- Análisis de la varianza para cada variable entre poblaciones.
- Análisis Discriminante Canónico
- Establecimiento de distancias de Mahalanobis entre poblaciones
- Construcción de clusters con las relaciones filogenéticas estimadas mediante las distancias.

Caraterización genética basada en marcadores en España

La caracterización basada en marcadores tiene como fundamento el polimorfismo en la expresión genética de fragmentos activos del ADN en forma de proteínas o enzimas y también en la observación directa del polimorfismo en fragmentos hipervariables del ADN. Entendemos el polimorfismo como un cambio en la forma, pero no en la naturaleza de las estructuras mencionadas, cambios que han ocurrido por mutaciones estabilizadas en la población (Fernández-Piqueras, 1993). Según Lucotte (1977) un determinado *locus* se considera polimórfico cuando el alelo más común se encuentra con una frecuencia igual o inferior a 0.99.

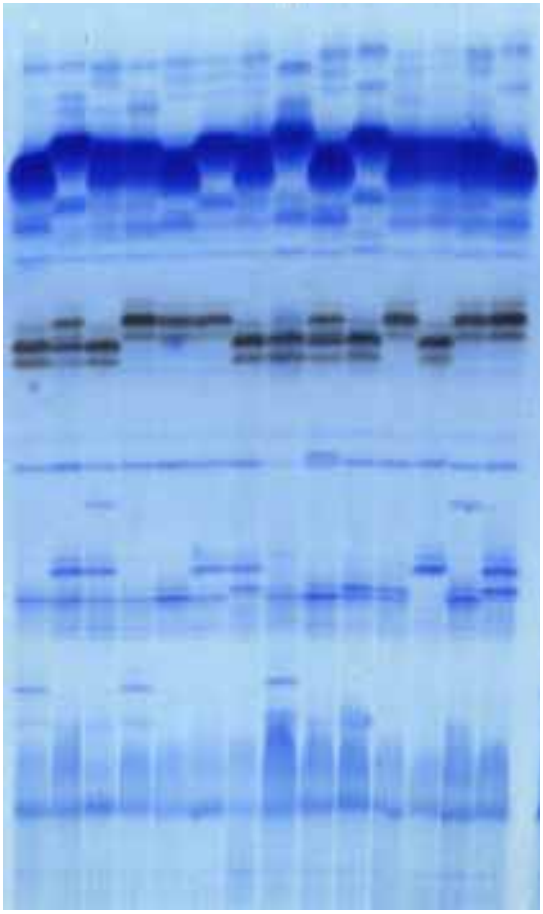

Figura 2. Electroforesis en gel de poliacrilamida de proteínas del suero.

Polimorfismos bioquímicos en España

Los distintos métodos electroforéticos permiten separar las distintas formas moleculares que pueda tener una proteína presente en todos los individuos de una especie. La influencia del campo eléctrico sobre las proteínas disueltas en solución acuosa hace que sus distintas formas migren a velocidad distinta desde un polo al otro en función de su carga y masa, separándose de esta forma en fracciones sencillas.

En España estas técnicas se imponen a principios de los ochenta con un triple fin, en primer lugar el apoyo al control genealógico de los animales con el propósito de la mejora; el segundo buscar ligazones de estos caracteres relativamente fáciles de medir con algunos caracteres de tipo cuantitativo de difícil medida y gran interés económico. Y finalmente la propia caracterización genética de las poblaciones.

Estas técnicas se desarrollan en tres facultades de Veterinaria de las cuatro que existían en España en aquellas fechas; el grupo de Zaragoza dirigido por el Prof. Zarazaga; el equipo de León coordinado en principio por el Prof. Vallejo y después por el Prof. San Primitivo y el equipo de Córdoba cuyo responsable era el Prof. Rodero. Estos equipos por separado y en ocasiones trabajando conjuntamente desarrollaron profundos estudios en el bovino español (González y col., 1987; Vallejo y col., 1977; y Vallejo y col., 1990) donde se caracterizaban trece razas bovinas españolas al mismo tiempo que se establecían las relaciones filogenéticas entre ellas.

En España los polimorfismos más profusamente estudiados en la especie bovina han sido el de la Hemoglobina, la Anhidrasa Carbónica, la Ceruloplamina, la Transferrina y la Albúmina.

Los pequeños rumiantes quizás por la complejidad de los controles genealógicos en sus sistemas de cría fueron las especies más estudiadas desde este punto de vista. En el ovino se abordó la caracterización de distintas razas individuales como fue el caso de la raza

Merina (Llanes, 1979, Morera y col., 1983; Garzón y col., 1976), la raza Rasa Aragonesa (Lasierra, 1974, Lamuela, 1974) y la Churra (San Primitivo y col., 1976; y Ordas y San Primitivo, 1986) y estudios conjuntos sobre distanciamiento genético basado en la información polimórfica (Rodero y col.,1982; Vallejo y col., 1977).

Algo similar ocurrió con los caprinos, donde también fueron profusos los trabajos de este tipo destacando en este caso los análisis conjuntos realizados sobre múltiples razas (Barbancho, 1979; Tuñón y col.,1984; Tuñón y col., 1989; Moreno y col., 1991; y Garzón 1975) sobre estudios individuales sobre razas concretas como la Murciano-Granadina (Garzón y col., 1976), la Malagueña (De la Haba y col. 1991) y la Canaria (Baena, 1990).

En el caso de los pequeños rumiantes la Hemoglobina, Anhidrasa Carbónica, la Proteína X, la Transferrina, la Esterasa, la actividad de la Glutation Peroxidasa y la Catalasa, además de los niveles de sodio y potasio.

Otra especie muy estudiada a este nivel ha sido la equina, manteniéndose aún un servicio de control genealógico en el Laboratorio de Grupos Sanguíneos, desarrollado mediante un convenio de

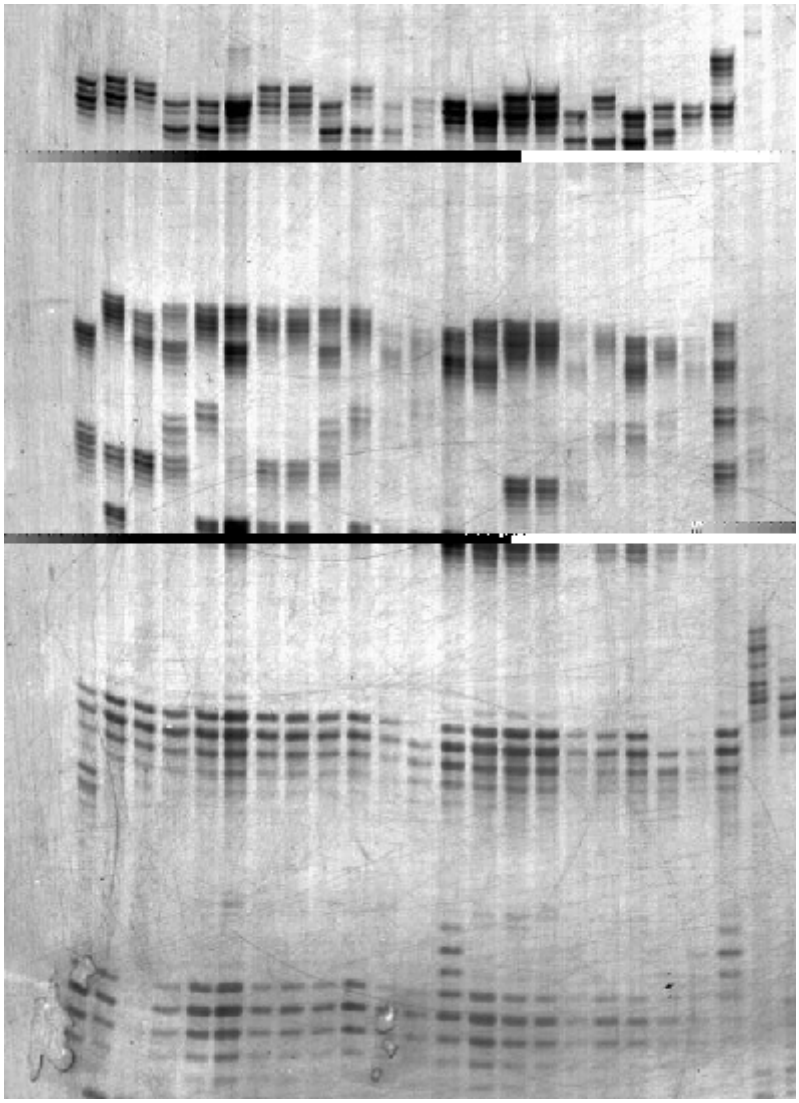

Figura 3. Electroforesis de productos de amplificación con PCR de microsatélites de ADN equino teñidos con plata.

colaboración entre el Ministerio de Defensa y la Universidad de Córdoba que aplica tanto esta metodología de los grupos sanguíneos como los microsatélites del ADN. Aunque el fin primordial de este grupo no era la caracterización, la fuente de información disponible les ha permitido desarrollar importantes estudios centrados en la Pura Raza Española en comparación con otros grupos raciales (De Andrés, 1982; Rodríguez y col., 1992).

En esta especie los polimorfismos más estudiados corresponden a la Hemoglobina, Esterasa, Transferrina, glicoproteína A1B, Albúmina, Proteína ligada a la vitamina D, G-fosfogluconatodeshidrogenasa, fosfoglucomutasa, alfa-1-antitripsina y glucosafosfatoisomerasa.

El procedimiento de trabajo es común y consiste de los siguientes pasos:

- Obtención de la solución acuosa de la proteína tras su extracción de la muestra, generalmente suero y células sanguíneas o suero lácteo.
- Electroforesis en distintos substratos
- Tinción de los geles
- Identificación de alelos e interpretación de resultados.
- Cálculo de frecuencias genotípicas y alélicas
- Establecimiento de distancias genéticas entre poblaciones
- Diseño de clusters con las relaciones filogenéticas establecidas con las distancias.

Las actividades enzimáticas precisan del contacto del enzima con un substrato para determinar la alta o baja actividad. Para el estudio de la bomba de sodio y potasio se utiliza la espectrofotometría.

Grupos sanguíneos en España

Existen unas estructuras proteicas en los hematíes que actúan como sustancias antigénicas produciendo reacciones inmunológicas específicas cuando son introducidos en individuos que carecen de las mismas. La utilidad de este fenómeno para la caracterización y para el control genealógico radica en la existencia de polimorfismo en dichos antígenos, constituyendo caracteres que desde el punto de vista genético se comportan como series alélicas, que dan un importante grado de variabilidad individual, si bien en el ámbito poblacional sus aportaciones son más limitadas que en el caso de los polimorfismos bioquímicos.

La identificación de los alelos y genotipos individuales se lleva a cabo a través de una reacción antígeno-anticuerpo aglutinante o hemolítica, utilizando sueros reactivos previamente tipificados y obtenidos de individuos sensibilizados con el antígeno específico.

En España se han utilizado los grupos sanguíneos en las especies ovina y equina fundamentalmente aunque escasamente en el ámbito de caracterización. En ovinos son destacables los trabajos desarrollados en la Facultad de Veterinaria de León (San Primitivo, 1976; San Primitivo y col., 1976, San Primitivo y col., 1977). Aunque debemos apuntar algunos trabajos desarrollados en la Universidad de Córdoba (Morera, 1982).

En la especie equina, al igual que ocurría en los polimorfismos bioquímicos, el estudio de los grupos sanguíneos ha sido liderado por el Laboratorio de Grupos Sanguíneos (Aguilar, 1985).

Complejo mayor de histocompatibilidad en España

Desde el punto de vista genético los fundamentos y utilidades de este sistema son similares a las descritas para los grupos sanguíneos. En este caso los antígenos se encuentran en las membranas celulares de las células nucleadas, como los linfocitos. Por esta razón la identificación de alelos y genotipos se lleva a cabo mediante reacciones antígeno-anticuerpo. Tras la relevancia observada por el estudio de este complejo en humanos como consecuencia de la evolución de los transplantes, se trató de implementar estas técnicas en las especies domésticas con los mismos fines que los grupos sanguíneos, pero además tratando de encontrar ligazones con algunas resistencias genéticas a enfermedades infecciosas y parasitarias.

En España se desarrollaron trabajos de esta naturaleza en Córdoba y el País Vasco, pero nunca con fines de caracterización.

Polimorfismo del ADN en España

Con el advenimiento de la tecnología del ADN recombinante en los años setenta se consiguió una nueva oportunidad para la identificación de marcadores genéticos, esta vez el polimorfismo se detectaba directamente sobre las propias moléculas del ADN.
Estos polimorfismos eran fundamentalmente de tres tipos:

- Fragmentos de restricción polimórficos (RFLP). Cuya variabilidad se debía a mutaciones en la secuencia de reconocimiento de una endonucleasa de restricción. La consecuencia de esto era el cambio en los patrones electroforéticos de estos fragmentos.
- Polimorfismos debidos a mutaciones puntuales que no afectan a dianas ni a la longitud del fragmento. Se detectan de forma indirecta como los Single Strand Conformation Polymorphism, SSCP, que aprovechan los cambios en la movilidad electroforética que presentan dos cadenas sencillas de ADN cuando se diferencian en una única sustitución de bases. También se detectan mediante secuenciación del ADN de la zona de interés o con técnicas de hibridación alelo-específicas.
- Repeticiones en tandem. El polimorfismo se debe a las repeticiones en tandem de un fragmento de ADN formado por un número variable de pares bases. Dependiendo del tamaño de la unidad que se repite nos encontramos con macrosatélites, en los que la secuencia repetida contiene entre 500 y varios miles de pares de bases. Los midisatélites, en los que la secuencia solo tiene entre 100 y 500 pares de bases. Los minisatélites, con secuencias entre 6 y 100 pares de bases. Finalmente los microsatélites, que repiten una pequeña secuencia de entre 1 y 6 pares de bases.

De todos estos polimorfismos, son los microsatélites los que presentan una mayor variabilidad y son muy fáciles de tipificar. Por esta razón son los más empleados para la caracterización genética de las poblaciones y para la identificación individual, de ahí que a continuación nos centraremos en ellos.

El protocolo de trabajo con los microsatélites se puede reducir a los siguientes pasos,

- Extracción del ADN de la muestra de sangre u otros tejidos (piel, pelo, músculo, etc.).
- Cuantificación del ADN extraído, utilizando generalmente la espectrofotometría.
- Amplificación mediante la reacción en cadena de la polimerasa (PCR).
- Evidenciación del producto amplificado mediante electroforesis en gel de agarosa para observar la eficiencia y rendimiento del proceso.
- Detección de alelos mediante electroforesis en gel de poliacrilamida.
- Visualización de los microsatélites mediante tinción con sales de plata, utilizando sales de plata o mediante cebadores marcados con fluorocromos empleando secuenciadores automáticos.
- Identificación de los alelos.

La metodología de análisis estadístico utilizada es como sigue:

a) Cálculo de frecuencia alélicas y genotípicas.
b) Cálculo de distancias genéticas
c) Diseño de clusters filogenéticos entre poblaciones utilizando las distancias.

En España, la utilización de los microsatélites como herramienta para la caracterización de poblaciones ha desplazado casi por completo al resto de marcadores genéticos descritos en el presente trabajo. En nuestro país debido a la estructuración política regional se han transferido a las comunidades autónomas las competencias en investigación agraria, y además se ha incrementado el número de universidades así como las dotaciones de las mismas. Esta

situación ha contribuido a que los equipos que trabajan en caracterización se han incrementado ampliamente.

La sensibilización por la conservación de los recursos genéticos animales también ha contribuido a que cada vez más equipos españoles se dediquen a la caracterización de nuestras razas autóctonas. Este interés ha afectado prácticamente a todas les especies de interés zootécnico.

En bovinos destacan los interesantes trabajos realizados por el equipo de la facultad de Veterinaria de León (Arranz, 1996; Arranz y col., 1997), aunque se han publicado otros trabajos de interés como los de Ruiz (1997) centrado en cinco razas bovinas, el de Zamorano (1998), que incluyó algunas razas criollas argentinas junto a los Berrendos españoles, y los trabajos del equipo de Viana en razas bovinas gallegas (Viana y col., 1998a, 1998b y 1998c).

En ovinos debemos destacar los trabajos de Arranz y col. (1995) en la raza Churra y de Zamorano y col. (1998) en el Merino de Grazalema y el Churro Lebrijano y Monteagudo y col. (1993) en la Rasa Aragonesa. Otros equipos trabajan en esta especie aunque sus resultados aun no han sido publicados, como es el caso del equipo de Valdepeñas que se ocupa del ovino Manchego.

En el caprino Canario, Mata y col. (Enviado) han empleado los microsatélites para clarificar la compleja estructura poblacional de la Agrupación Caprina Canaria, aunque sus resultados aun no han sido publicados.

En el Porcino, nuestro equipo ha utilizado la batería de 30 microsatélites propuesta por la ISAG y la FAO para la caracterización porcina para definir la estructura poblacional del cerdo ibérico y el Manchado de Jabugo (Delgado y col., 1998; Martínez y col., 2000a; Martínez y col., 2000b), estando en proceso la misma aplicación el Cerdo Negro Canario y el Chato Murciano. Otros equipos de Baleares y Zaragoza han trabajado sobre el Chato y el cerdo Negro Mallorquín. Así mismo el CIT/INIA de Madrid ha realizado interesantes estudios para la caracterización del cerdo ibérico.

En equinos son fundamentalmente tres equipos los que se ocupan de la aplicación de los microsatélites en estas especies. El Laboratorio de Grupos Sanguíneos de Córdoba (Vega-Pla, 1996) aportando incluso tres nuevos microsatélites de aplicación (Vega y col. , 1996). El equipo del Departamento de Producción Animal de la Universidad Complutense de Madrid que se ha ocupado del estudio de los ponies españoles (Checa y col., 1998, Cañón y col., 2000). Y el equipo de la Facultad de Veterinaria de Zaragoza que ha centrado su estudio en el poni vasco Pottoka.

En la especie canina también se han aplicado los microsatélites con intensidad para estudios de caracterización racial. Morera y col. (1999) han aplicado una batería de microsatélites en el análisis comparativo de cuatro razas autóctonas españolas de perros. También es de interés el trabajo realizado por Gómez y col. (1998) con ADN mitocondrial en cuatro razas caninas.

Finalmente queremos destacar que cada vez se introduce mas en la bibliografía internacional la aplicación de los RAPD (Random Amplified Polymorphic DNA) con fines caracterizadores. Esta técnica se basa en la creación de conjuntos de ADN raciales desde la mezcla de muestras de animales aleatoriamente escogidos en la población. Tras la amplificación con cebadores inespecíficos y sometimiento a electroforesis, se detectan polimorfismos poblacionales a modo de patrón. Este método ha sido utilizado en España por Parejo y col. (1998) en la raza bovina Blanca Cacereña, si bien se están aplicando en la actualidad por otros equipos en la especie porcina.

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Characteristics of the American Polypay: A review

G.D. Snowder

*USDA, ARS, U. S. Sheep Experiment Station, **Dubois**, Idaho 83423, USA*

Summary

The Polypay sheep breed was developed at the U.S. Sheep Experiment Station with a reproductive capacity markedly superior to that of domestic US western range breeds. The Polypay is a four breed composite of Targhee, Rambouillet, Dorset and Finnish Landrace breeds. It is a medium-sized wool sheep (average mature ewe weight of 72 kg) with a smooth body free of excessive skin wrinkles on the neck and body and a poll head. Comparative studies with other US domestic breeds have shown the Polypay to have earlier sexual maturity, higher fertility and prolificacy rates. Mature ewes give birth to an average of 2.4 lambs and wean an average total litter weight of 63.8 kg per ewe at 120 days post partum. Lamb survival rates to 21 and 120 days are greater than those of other breeds compared. Average individual lamb weaning weight at 120 days (36.1 kg) exceeded that for Rambouillet and Targhee lambs (34.5 and 33.8 kg, respectively). Polypay carcasses are similar to those of Rambouillet and Targhee for dressing percentage, body wall thickness, kidney and pelvic fat, and ribeye area. Measures of carcass fat are less in the Polypay when compared to the Rambouillet and Targhee while qualitative leg scores for the Polypay were more favorable. Productive longevity under western range herded conditions does not differ among Polypay, Rambouillet, Targhee and Columbia sheep. In a farm flock production system, the average number of productive years for Polypay ewes exceeded that of most crossbred types. Wool characteristics are defined as a coarse to medium grade wool with a fiber diameter ranging from 24 to 33 µm. Fiber staple length ranges from 7.6 to 12.7 cm with a common mean of approximately 10 cm. Raw fleece weights are considered light and range from 2.7 to 4.5 kg. Yield of clean wool is approximately 57 percent. Economic evaluations favored the Polypay in all production systems considered with 15 to 36 percent increase in sales or profits compared to other US domestic breeds. When considering the Polypay breed for importation, some prudence should be exercised because it may not be suitable to all environments and production systems in the world, especially where nutritional and management resources are not sufficient to support lactating ewes rearing twins.

Resumen

La raza ovina Polypay fue desarrollada en la Estación Experimental Ovina de EE.UU. con una capacidad de reproducción claramente superior a la media de las razas locales de la zona oeste de EE.UU. La raza Polypay está compuesta por cuatro razas: la Targhee, la Rambouillet, la Dorset y la Finnish Landrace. Se trata de una raza de lana de mediana estatura (el peso medio de la oveja en edad madura es de 72 kg), con un cuerpo suave sin exceso de piel arrugada en la nuca y en el cuerpo y ausencia de cuernos. Estudios comparativos con otras razas locales estaduinenses han mostrado que la Polypay posee una madurez sexual precoz, y mayor grado de fertilidad y prolificidad. Las ovejas maduras paren una media de 2,4 corderos y los crian hasta un peso medio de 63,8 kg a los 120 días del parto. La supervivencia de los corderos de 21 a 120 días es superior a la de otras razas comparadas. La media individual de peso al destete a los 120 días (36,1 kg) es mayor que para la raza Rambouillet y Targhee (34,5 y 33,8 kg, respectivamente). Las canales de Polypay son semejantes a las de

Rambouillet y Targhee en cuanto al porcentaje de manto, espesor corporal, grasa entorno a riñones y zona pélvica, y área del músculo dorsal. Las cantidades de graso de la canal son inferiores en la Polypay comparadas con la Rambouillet y la Targhee, mientras que los índices cualitativos de las patas son más favorables en la Polypay. La longevidad productiva en condiciones de rebaño en las regiones del oeste no es diferente entre la Polypay y las razas Rambouillet, Targhee y Columbia. En un sistema de producción en granja la media de años productivos en las ovejas Polypay no excede la media de la mayor parte de tipos de razas cruzadas. Las características de la lana vienen definidas de gruesa a media con un diámetro de fibra que va de 24 a 33 µm. La longitud de la fibra a la raíz va de 7,6 a 12,7 cm con una media aproximada de 10 cm. Los pesos de vellón crudo están considerados como bajos y van de 2,7 a 4,5 kg. La superficie de lana limpia representa aproximadamente el 57%. Las evaluaciones económicas favorecen a la raza Polypay en todos los sistemas de producción considerados, con un porcentaje de 15 a 30% de aumento en la venta o en las ganancias en comparación con las demás razas locales en EE.UU. Si consideramos la raza Polypay para la importación debemos tener cierta prudencia, ya que no resulta adecuada a todos los medios y a todos los sistemas de producción en el mundo, en particular allí donde los recursos nutricionales y de manejo son insuficientes para consentir la lactación de ovejas con partos gemelares.

Key words*: Polypay sheep, Reproduction, Genetics, Wool, Lamb.*

Introduction

A new synthetic breed is usually created to meet a need not currently met by existing breeds and may be developed more quickly than by waiting over a longer period for the slower selection response of existing breeds. The Polypay breed is perhaps the best example of a successful new breed with increasing popularity in the USA and Canada. The breed was developed as a four-breed composite at the U.S. Sheep Experiment Station, Dubois, Idaho during the 1970's. The Polypay breed was originally developed as a range breed with superior reproductive performance compared to traditional sheep breeds under herded grazing conditions of the Rocky Mountain region of the northwest USA. However, the breed was quickly accepted by many farm flock producers because of its high prolificacy rate, out-of-season breeding ability, and capability to produce two lamb crops annually. The profitability of the Polypay has been demonstrated to exceed that of other American range breeds (Knight and Snowder, 1995). This paper reviews the characteristics of the Polypay breed.

Discussion

Characterization of the Polypay must be based on research findings and in comparison with known reference breeds. Research on the Polypay breed has generally been performed at the U.S. Sheep Experiment Station under extensive range management. Limited research has been reported under intensive farm flock production. The Polypay breed has been compared with reference breeds including the Rambouillet, Columbia and Targhee. The Rambouillet is a wool breed of Merino descent and a common US western range breed. The Columbia and Targhee breeds were developed at the U.S. Sheep Experiment Station and are less known abroad. The Columbia was developed about 1912 from mating Rambouillet ewes to Lincoln rams (Marshall, 1949) to produce a large-frame ewe that would produce lambs with the potential for heavier carcasses. The Targhee was developed in 1926 by backcrossing the Lincoln-Rambouillet crossbred to the Rambouillet (Terrill, 1947) with the breeding objective of improved wool characteristics. The acceptance of the Polypay depends on its ability to improve profitability when compared with these traditional breeds under similar management and production systems.

Breed development

The Polypay breed was developed by Dr. Clarence Hulet at the U.S. Sheep Experiment Station. Dr. Hulet's breeding objective was to develop a breed with a reproductive capacity markedly superior to that of domestic western range breeds (Hulet *et al*., 1984). He selected four breeds with desirable characteristics to produce the composite breed: Finnish Landrace with its high prolificacy and early puberty; Rambouillet and Targhee because of their adaptability to western range conditions, herding instinct, and fleece characteristics; and the Polled Dorset with early puberty, extended breeding season, milking ability, and favorable carcass characteristics. In 1968, six imported Finnish Landrace rams were bred to foundation Rambouillet ewes to produce Finnish Landrace x Rambouillet crosses. Four unrelated large-bodied Dorset rams born as twins from ewes with outstanding lifetime production records were mated to Targhee ewes to produce Dorset x Targhee crosses. In 1970, the first 4-breed composites were born from crossing Finnish Landrace x Rambouillet sheep to Dorset x Targhee sheep. The 4-breed composites were then *inter se* mated and selected heavily for lamb production.

Evaluation of the 4-breed composite occurred for several years with the conclusion that the composite met the original breeding objectives. In 1975, Dr. Hulet named the composite "Polypay" from 'poly' meaning many or much, and 'pay' to indicate profitability. The first Polypay sheep were sold to the public at the U.S. Sheep Experiment Station in 1975. The American Polypay Sheep Association was formed in 1980. Today, there are an estimated 150 Polypay purebred sheep flocks with an undetermined number of commercial flocks in the USA.

Criticisms of the breed occurred early in its development and were based on comparison with the more familiar range breeds of Targhee and Rambouillet. Some criticisms were justified while others were unfounded. Polypay sheep were smaller in mature body size and often exhibited conformation characteristics of the Finnish Landrace such as fine bone structure and pink skin pigmentation of the eye, nose, and ear areas. Because of the larger litter sizes born to Polypay ewes, lamb birth weights were lighter and there were concerns about lamb survival and growth rates. Initially, Polypay fleeces were too variable in fiber diameter and staple length, and too light weight. Continued selection and research on the Polypay at the U.S. Sheep Experiment Station and on private farms has affirmatively addressed all of these early criticisms.

Ewe body size and conformation

During the early stages of the breed development, a moderate body size that would be reproductively efficient was desirable. Initial selection criteria always emphasized superior reproductive performance with no concurrent selection pressure applied to increase body size. However, mature body size gradually increased among Polypays. During a recently concluded 12 year selection study at the U.S. Sheep Experiment Station in which selection was based solely on total litter weight weaned at 120 days postpartum under western range grazing conditions, total litter weight increased an average of 0.70 kg per year and the correlated response in ewe body weight was an increase of 0.82 kg per year (Ercanbrack and Knight, 1998). Consequently, the mature size of the breed has increased with increased lamb production under range conditions. Currently, the average body weight for a mature Polypay ewe is 72 kg, and in some flocks the average mature ewe weight may range from 60 kg to 82 kg. By comparison, Polypay ewes are approximately 95 percent of the mature size of Rambouillet and Targhee ewes at the U.S. Sheep Experiment Station.

The general appearance of the Polypay is a medium sized wool sheep with a smooth body free of excessive skin wrinkles on the neck and body (Figures 1 and 2). The head is

Figure 1. Yearling Polypay ram.

Figure 2. Mature shorn Polypay ewes and lambs.

Table 1. Reproductive performance of Polypay ewes by age.

Age	Number of observations	Breeding Season	Fertility (%)	Lambs Born	Lambs Weaned	Weaningage	Litter weight weaned (kg)	Source
7 to 8 months	98	Fall	95	n/a	n/a	n/a	n/a	Hulet *et al.*, 1984
6 to 18 months	1 921	Fall	n/a	1.50	n/a	n/a	n/a	Notter, 2000
1 year	53	Fall	94	n/a	1.17	90	26.4	Ramdas *et al.*, 1993
1 to 6 years	236	Fall	96	1.74	n/a	n/a	n/a	Nawaz and Meyer, 1992
Mature, > 2 years	50	Fall	90	2.07	1.64	120	n/a	Hulet and Ercanbrack, 1979
Mature, > 30 months	2 392	Fall	n/a	2.13	n/a	n/a	n/a	Notter, 2000
Mature, > 3 years	789	Fall	96	2.37	1.73	120	63.8	Snowder (unpublished data)
Mature	2 031	Fall	95	2.03	1.44	120	41.6	Ercanbrack and Knight, 1998
6 to 18 months	45	Spring	n/a	1.26	n/a	n/a	n/a	Notter, 2000
1 year	14	Spring	52	n/a	n/a	n/a	n/a	Hulet *et al.*, 1984
18 to 30 months	225	Spring	n/a	1.62	n/a	n/a	n/a	Notter, 2000
Mature, > 30 months	697	Spring	n/a	1.74	n/a	n/a	n/a	Notter, 2000

polled with an open white face. Ears are medium length and covered with white hair. Mature ewes are 70 to 85 cm tall when measured to the shoulder. Undesirable pink skin pigmentation on the eye, nose, and ear was frequently observed in the early generations of the breed's development but has been largely eliminated by selection.

Reproductive characteristics

The Polypay breed is well known for its early puberty and high prolificacy rate. Reproductive performance of the Polypay has been well investigated (Table 1). Hulet *et al.* (1984) reported a conception rate at fall season breeding of 94 to 97 percent for 7 to 8 month old Polypay ewes compared to 16 to 37 percent for Rambouillet and 57 to 73 percent for Targhee ewe lambs. At older ages, conception rates for fall season breeding generally average 95 percent. Average number of spring born lambs per yearling ewe exposed is 1.5 (Notter, 2000). Mature ewes typically give birth to 1.7 to 2.4 spring born lambs, depending upon management and production system. By comparison with most other non-Finnish Landrace crossbred and purebred breeds in the USA, the Polypay has one of the highest levels of fertility and prolificacy (Hulet *et al*., 1984; Nawaz and Meyer, 1992; Ramdas *et al*., 1993; Ercanbrack and Knight, 1998; Notter, 2000).

Also, the Polypay has been reported to have heavier litter weight weaned per ewe and adjusted individual lamb weaning weights compared to many different crossbred and purebred types (Hulet and Ercanbrack, 1979; Hulet *et al*., 1981; Ercanbrack and Knight, 1985 and 1989; Nawaz *et al*., 1992; Knight and Snowder, 1995). Litter weight weaned at 120 days postpartum has steadily increased in selected Polypay lines at the U.S. Sheep Experiment Station. The average 120 day litter weight weaned at the U.S. Sheep Experiment Station from 1976 to 1988 was 41.6 kg (Ercanbrack and Knight, 1998) while the present average is 63.8 kg (Snowder, unpublished data). Because direct and genetic responses to selection for litter weight weaned in this flock have shown steady improvement (Ercanbrack and Knight, 1998) the biological optimal production level for this trait has not been observed under the management and production system evaluated. Litter weight weaned is a composite trait and genetic improvement in this trait was attributed to correlated improvements of prolificacy, lamb survival, lamb weaning weight, ewe fertility, and ewe viability (Snowder *et al*., 1996; Ercanbrack and Knight, 1998).

Ovulation rate and uterine efficiency of the Polypay exceeded that of numerous crossbred types (Nawaz and Meyer, 1991). At 5 and 6 years of age, the average ovulation rate for Polypay ewes was observed to be 1.94. This resulted in 1.88 lambs born per ewe ovulating, or uterine efficiency of 96 percent.

Table 2. Average reproductive performance of mature Polypay ewes in once- and twice-a-year lambing groups[a].

Lambings per year	Number exposed	Lambs born	Lambs weaned	Litter weight weaned (kg)
Once in fall	165	1.83	1.49	46.5
Twice				
Winter	242	1.74	1.41	47.9
Summer	190	0.47	0.37	11.7
Total annual	242	2.11	1.70	57.1

[a] Production expressed on a per ewe exposed basis.
Source: Hulet *et al*., 1984.

Nawaz and Meyer (1991) also reported that the association between body weight and ovulation rate was largest in the Polypay compared to crossbred types and predicted a 10 percent increase in body weight increases ovulation rate by 6 percent. This agrees with the correlated increase in Polypay body weight observed by Ercanbrack and Knight (1998) when selection emphasized total litter weight weaned.

Season of lambing alters the expression of prolificacy in Polypays. Compared to spring lambing, average prolificacy of mature ewes was reduced by 0.24 lambs in the summer and 0.31 lambs in the autumn (Notter, 2000).

Occasionally, the Polypay has been managed in commercial twice-a-year lambing production systems. Comparisons of once- and twice-a-year lambings suggest that lamb production can be increased (Table 2; Hulet *et al*., 1984). However, the economic parameters for lambing twice-a-year can vary significantly and producers should consider such parameters to estimate the profitability of twice-a-year lambing. Twice-a-year lambing is not common in the USA, rather production systems with 3 lambings in 2 years occasionally exist.

Reproductive characteristics were reported on a small sample of Polypay rams (n=4) by Fitzgerald and Stellflug (1990). They concluded that two and one-half year old Polypay rams exhibited greater libido in long season days, had greater epididymal reserves of sperm and similar scrotal circumferences when compared to Rambouillet and Columbia rams.

Birth and growth characteristics

Polypay lambs weigh less at birth than those born to Rambouillet and Targhee ewes. This difference is due to both a maternal influence and a result of the higher percentage of lambs born in multiple birth litters. Average birth weights of twin or triplet born Polypay lambs are 4.1 and 3.7 kg, respectively. Lower incidences of dystocia or assisted births have been observed for both single and multiple births in Polypay ewes when compared to crossbred ewes (Nawaz and Meyer, 1992).

Survival of Polypay lambs exceeds that of traditional breeds (Snowder and Knight, 1995). Table 3 shows the superiority of the Polypay's survival from both birth to 21 days of age and from 21 days of age to 120-day weaning age compared to Rambouillet and Targhee lambs under western range conditions of the USA. Increased survival rates of Polypay lambs may be the result of its Finnish Landrace genetic component; higher survival rates for crossbred Finnish Landrace lambs have often been reported (Oltenacu and Boylan, 1981; Ercanbrack and Knight, 1985 and 1989; Gama *et al*., 1991).

The maternal influence of the Polypay breed on lamb survival may also be important. Snowder and Knight (1995) investigated the effect of breed of foster dam on lamb survival to weaning at 120 days when breed of lamb and foster dam differed. They reported higher rearing success for Polypays (86 percent) than for Rambouillet (84 percent), Targhee (75 percent), or Columbia foster ewes (82 percent).

Table 3. Survival rate (%) of lambs by breed from birth to 21-day of age and thereafter to 120-day weaning age.

Breed	21-day	120-day
Polypay	96.2	92.8
Rambouillet	93.1	89.9
Targhee	91.4	86.7

Source: Snowder and Knight, 1995.

A production concern associated with the Polypay is inadequate milk production for first parity ewes especially those rearing twin lambs (Snowder *et al*., 2001a and 2001b). This is a common production concern among high prolificacy breeds. Generally, commercial producers will remove one twin lamb from a ewe with inadequate milk production and attempt to graft it onto a ewe capable of raising the orphan, but this is labor intensive and not always successful. First parity subjective milk scores are associated with both lamb survival and pre-weaning growth rate (Snowder *et al*., 2001a), and milk production at first parity can be improved at a moderate rate by selection (Snowder, 2001b).

Because the American Polypay Sheep Association (Milo, Iowa) maintains an open registry book which permits the introduction of new germplasm for breed improvement, crossbreeding the Polypay with a milking sheep breed may be feasible. The U.S. Sheep Experiment Station used crossbreeding to produced ¼ East Friesian ¾ Polypay ewes and is evaluating their first parity milking performance when compared to purebred Polypays.

Growth rate of Polypay lambs compares favorably to other white-faced western breeds. Under western range conditions where ewes and lambs are herded in flocks of approximately 1 000 ewes on open mountain ranges at elevations ranging from 2 000 to 2 900 m, lambs are weaned at approximately 120 days of age. Average weaning weight was heavier for Polypay lambs (36.1 kg) than for Rambouillet (33.8 kg) or Targhee lambs (34.5 kg) (Snowder and Knight, 1995). Post weaning growth rate of Polypay lambs has also been found to be comparable to that of Rambouillet and Targhee lambs, both in grazing and feedlot situations (unpublished data).

Carcass characteristics

During the early years of the Polypay development, lambs with Finnish Landrace breeding were disliked by the US lamb packing industry because of their lighter carcasses and smaller frames. However, extensive research studies under a wide variety of production conditions found that when ¼ and ½ Finnish Landrace ewes were mated to meat-type terminal rams such as the Suffolk, resulting crossbred lambs were hardy and of acceptable carcass quality (Boylan *et al*., 1976; Thomas *et al*., 1976; Dickerson, 1977; Dahmen *et al*, 1979; Magid *et al*., 1981; Snowder *et al*., 1986).

A recent study found lamb carcasses of purebred Polypays similar in most respects to those of Rambouillets, Targhees, and Columbias. (Snowder *et al*., 1994). Carcass measures of Polypay and traditional breed

Table 4. Least squares means for carcass traits of four sheep breeds[a].

Trait	Polypay	Rambouillet	Targhee	Columbia	SEM
Slaughter wt., kg	53.7	53.3	52.3	53.9	0.61
Dressing, %	51.5[b]	50.4[b]	50.1[b]	49.3[c]	0.21
Backfat depth, mm	7.2[bd]	8.6[c]	7.7[bc]	6.3[d]	0.03
Body wall thickness, cm	2.4[bd]	2.5[b]	2.7[c]	2.3[d]	0.05
Kidney and pelvic fat, %	3.9[b]	4.2[b]	4.0[b]	3.1[c]	0.11
Ribeye area, cm^2	12.3	12.9	12.3	12.3	0.18

[a] Source: Snowder and Knight, 1995.
[b,c,d] Values within a row with different superscripts differ (P>.05).

lambs are presented in Table 4. Polypay carcasses were similar to those of Rambouillet and Targhee for dressing percentage, body wall thickness, kidney and pelvic fat as a percentage of the carcass weight, and ribeye area. Measures of fat (back fat depth, body wall thickness, and kidney and pelvic fat percentage) were less in the Polypay when compared to the Rambouillet and Targhee. Visually evaluated qualitative leg scores were more favorable for the Polypay than the other three breeds in the study.

Wool characteristics

Polypay sheep produce coarse to medium grade wool with a fiber diameter ranging from 24 to 33 µm. Fiber staple length ranges from 7.6 to 12.7 cm with a common mean of approximately 10 cm. Raw fleece weights are considered light and range from 2.7 to 4.5 kg. Polypay ewes at the U.S. Sheep Experiment Station typically shear 3.6 kg of wool. The average clean wool yield is approximately 57 percent. Average lifetime fleece weights for ¼ Finnish Landrace crossbred ewes were reported to be 95percent as heavy as those of purebred sheep (Columbia, Rambouillet and Targhee; Ercanbrack and Knight, 1989). Yearling fleece weights of first generation Polypay ewes were 8 percent lighter than those of Targhees (3.05 *vs* 3.33 kg; Ramdas *et al*., 1993). Table 5 summarizes four years (1997 to 2000) of Polypay ram wool data collected from the U.S. Sheep Experiment Station. Ram lambs produce lighter fleeces (2.8 kg) with finer fiber diameters (23.5 µm) wool than 2 year old rams (4.1 kg and 26.9 µm, respectively). The Polypay breed has improved in fleece uniformity during the 25 years since its release. Selection for improved wool characteristics has been practiced in private flocks but is less emphasized since the worldwide decline in wool prices.

Processing characteristics of Polypay wool were not favorable as a worsted yarn (Stobart *et al*., 1986). Yield of processed scoured top ranged from 77 to 82 percent with a high level of waste (noils) 18 to 24 percent. The high percentage of noils was related to a fiber strength problem caused by breakage during the high stresses imposed by the worsted processing system. The percentage of medullated fibers ranged from 0.2 to 1.6 percent across the ages of 1 to 4 years; levels exceeding 0.5 percent decrease the economic value of the yarn. Additionally, yarns of Polypay wool did not have acceptable evenness values (coefficient of variation of 16 to 26 percent) when compared with Uster standard values. Tenacity values (tensile strength of 4 to 7 cN / tex) were lower than the Uster Statistics, indicating fabrics made of Polypay wool would be of marginal quality for worsted processing. However, Polypay wool would be of similar value to that of most coarse to medium grade wool breeds.

Flocking behavior

The flocking behavior of Polypay sheep has not been reported; however, the frequent use of Polypay sheep under herded conditions on open range of the intermountain western region of the USA suggests that they have an acceptable herding instinct. Hulet *et al.* (1992)

Table 5. Fleece and fiber characteristics of Polypay rams.

Age	No. of rams	Fleece weight, kg	Fiber diameter, µm	
			Average	Range
10 to 11 months	251	2.8	23.5 ± 1.6	19.3 to 28.9
2 year	105	4.1	26.9 ± 1.8	22.5 to 32.5

reported no differences in the flocking behavior between Rambouillet and Rambouillet x Polypay female sheep but did observe significant differences in flocking behavior as affected by flock size and age groups.

Production longevity

Polypay sheep tend to live and produce as long as Rambouillet, Targhee and Columbia sheep under western range herded conditions (Snowder, unpublished data). In a university farm flock production system, the average number of productive years for Polypay ewes has exceeded that of some crossbred types (Nawaz *et al*., 1992; Ramdas *et al*., 1993). When observed from 1 to 7 years of age, the length of time a ewe remained productive under range conditions did not differ between ¼ Finnish Landrace crossbred ewes and Rambouillet, Targhee and Columbia purebred ewes (Ercanbrack and Knight,1985 and 1989) although the highest attrition rates occurred in purebreds. Iniguez *et al*. (1986) reported that production longevity of Rambouillet x Finnish Landrace and Dorset x Finnish Landrace crossbred ewes in a farm flock fall lambing production system was equal to or greater than that of Rambouillet or Dorset ewes.

Economic evaluation

In most sheep producing countries of the world today, the production trait with the highest profitability is weight of quality lamb marketed per ewe exposed. This is a composite trait dependent upon reproduction, maternal ability, lamb survival, lamb growth, and slaughter value. The value of wool accounts for less than 10 percent of the gross income and may even be a cost when shearing expenses exceed the return. Therefore, sheep producers would be wise to seek out those breeds that enhance profitability.

The economic advantage of the Polypay breed in the USA has been well documented. Hulet *et al*. (1981) compared gross sales from wool and lamb production in four breeds and Finnish Landrace crosses under range conditions. Gross sales from Polypay and Finnish Landrace cross mature ewes were significantly higher than Rambouillet, Targhee, and Columbia mature ewes by 21, 30, and 36 percent, respectively. Hulet *et al*. (1981) concluded that the Polypay's moderate body size and increased reproductive rate made it more profitable. Ercanbrack and Knight (1985 and 1989) reported a 15 to 18 percent greater net value of lifetime production from a ¼ Finnish Landrace crossbred compared to adapted domestic breeds. Knight and Snowder (1995) considered the economic status of production systems with reproduction and wool levels varying according to traditional breeds (Rambouillet) and Finnish Landrace crosses (Polypay) as affected by increased grazing fees on public range and the loss of the federal wool incentive program. The early puberty and increased lamb production of Polypay ewes resulted in a profitable range sheep production system while production systems with traditional breeds were predicted to be unprofitable under most scenarios studied.

Biological efficiency as defined as the annual litter weight weaned divided by mean ewe weight$^{0.75}$ was reported to be highest in the Polypay breed compared to various crossbred types in a farm flock production system (Nawaz *et al*., 1992).

Limitations to the environment and production systems in which the Polypay may be profitable probably exist. Some sheep producers found Polypay or Finnish Landrace crossbreds to be undesirable for their production system (Snowder *et al*., 1986). These unsuccessful attempts have usually occurred in desert regions where environmental conditions would be expected to be less conducive to maintaining a lactating ewe rearing twin lambs. Some producers have objected to the increased labor required at lambing to assist more new born lambs to suckle, although this concern may be minimal.

Conclusions

The Polypay breed, by comparison to most other US sheep breeds, is a highly productive breed under the range and farm flock production systems where it has been studied. The breed may also be profitable in other parts of the world where lamb production is the most economically important trait. The medium coarse wool is not of significant value at present wool prices. Also, importation by foreign countries may expose the breed to diseases to which it is not immune. The Polypay breed appears to meet most criteria to be a profitable breed under current US production systems.

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Genetic diversity between Italian and Greek buffalo populations

B. Moioli[1*], A. Georgoudis[2], F. Napolitano[1], G. Catillo[1], S. Lucioli[1], Ch. Ligda[2] & J. Boyazoglu[2]

[1]Istituto Sperimentale per la Zootecnia, via Salaria 31, 00016 ***Monterotondo****, Italy*
[2]Dept. of Animal Production, Aristotle University of Thessaloniki, 54006 ***Thessaloniki****, Greece*

Summary

The present study is a first step of a global project aiming at the estimation of the genetic distances and relationships among buffalo breeds and sub-populations and the investigation of the production potential and adaptability of different buffalo genotypes in various environments.

Genetic diversity of Italian and Greek buffalo populations was estimated on the basis of allele frequencies at nine polymorphic microsatellite loci: CSSM43, CSSM38, DRB3, D21S4, CYP21, CSSM47, CSSM60, CSSM36 and CSSM33. The number of detected alleles per locus varied from two (D21S4) to thirteen (CSSM47). Allele frequency distribution was similar in the two populations, which have the same alleles at the highest frequency at all loci, except loci CSSM47 and CSSM60. Average gene diversity over all loci was 0.60. Across-loci average gene diversity increased with the number of alleles. Observed average heterozygosity was 0.167 and 0.177 in the Italian and Greek populations, respectively. The degree of differentiation between Italian and Greek buffalo was moderate and estimated at 0.021 ± 0.009.

Resumen

El presente estudio representa un primer paso dentro de un proyecto global orientado a la estimación de las distancias genéticas y relaciones entre las razas de búfalos y las sub poblaciones y la investigación sobre la producción potencial y la adaptabilidad de los distintos genotipos de búfalos en condiciones ambientales diversas.

La diversidad genética de las poblaciones italianas y griegas de búfalos fue estimada en base a las frecuencias de alelos en nuevo loci microsatélites polimórficos: CSSM43, CSSM38, DRB3, D21S4, CYP21, CSSM47, CSSM60, CSSM36 y CSSM33. El número de alelos detectados por locus varió de dos (D21S4) a trece (CSSM47). La distribución de la frecuencia de los alelos fue similar en las dos poblaciones, que poseen los mismos alelos en la frecuencia más alta en todos los loci, excepto los loci CSSM47 y CSSM60.

La media de diversidad de genes en todos los loci fue de 0,60. Entre los loci la media de diversidad de genes aumentó con el número de alelos. La media observada de heterocigosidad fue de 0,167 y 0,177, en las poblaciones italianas y griegas respecitvamente. El nivel de diferenciación entre el búfalo italiano y griego fue estimado en 0,021±0,009.

Keywords*: Buffalo, Microsatellites, Genetic diversity*.

[*]Corresponding author.
Tel.: +39-06-900901; Fax: +39-06-9061541
E-mail address: isz@flashnet.it

Introduction

Domestication of water buffalo occurred 5 000 years ago, more recently than the domestication of *Bos taurus* and *Bos indicus* (10 000 years ago) (Loftus *et al*., 1994). Compared to cattle, buffalo productivity in meat and milk is generally lower, therefore, buffalo farming was abandoned in many countries and left to the areas where cattle were not able to produce efficiently due to climate, parasites, muddy lands, etc. and draught power is still needed. Buffaloes are now raised only in thirty countries in the world, from which over 96 percent are in Asia (Cockrill, 1974, 1984; Bhat, 1992).

Although in past centuries a worldwide exchange of cattle breeds, together with the adoption of similar management and selection schemes have taken place, every country followed their own path in the management of their respective populations as dictated by local conditions. The result of this process was a wider differentiation of populations and productive traits, accentuated by the non-consistent exchange of genetic material between countries (Bhat, 1992; Mahadevan, 1992; Boyazoglu, 1996).

The scientific community is aware of the negative effects produced by the loss of variation in animal genetic resources, due to human interference. Livestock biodiversity is important because the genes and gene combinations they carry may be useful in the future for traits that are presently unknown or difficult to define, e.g. disease and stress resistance, quality and composition of products, adaptation to different environments or farming systems (Boyazoglu and Flamant, 1990; Matassino and Moioli, 1996; Hammond, 1998; Boyazoglu, 1999).

In this context, the investigation of genetic relationships among buffalo populations in order to study their origin, domestication and

Figure 1. Italian buffalo in Tor Mancina farm, Rome, Italy.

genetic structure, will provide a useful tool in supporting conservation decisions and designing of breeding schemes.

The present study is a first step of a global project aiming at the evaluation of the genetic distances and relationships among buffalo populations and the investigation of production potential and adaptability of different buffalo genotypes in various environments. The implementation of the project started with the comparison of Italian and Greek buffalo populations.

In Italy in the past, buffalo was neglected, it was a poor milk producer but able to survive in unhealthy swampy lands. It has now become a highly desired livestock, which produces top quality and the highest-in-demand cheese (Rossi *et al.*, 1998). There are 150 000 buffaloes in Italy, 85 percent of them concentrated in Central-Southern regions. The average herd size is 50-100 animals. The low rate of AI use and the little exchange of breeding stocks among farms could lead to the independent genetic development of the herds (Pilla and Moioli, 1992).

In Greece, due to the rapidly changing socio-economic conditions, including the mechanization of the agricultural sector and the introduction of imported dairy cattle breeds, the number of buffaloes has declined dramatically over the last decades. As a result, from the 75 000 animals counted at the end of the 1950s, today only 1 000 heads remain in some wetlands in Northern Greece, particularly in the regions of Macedonia and Thrace. The population is distributed in 12 herds with an average herd size of 85 heads. These animals are mainly used for milk and meat production (Georgoudis *et al.*, 1994, 1998).

Recently, the developments in DNA technology for identification of genes and QTLs, provide useful tools in analyzing the genetic diversity and managing farm animal genetic resources. Microsatellites, which are now generally considered the most powerful genetic markers to describe genetic animal population variability, were proposed for the analysis of animal genetic diversity by the Expert Working Group in the Secondary Guidelines for Development of Farm Animal Genetic Resources Management Plans, Measurement of Domestic Animal Diversity (FAO, 1998). The protocol in these guidelines is being followed in the present project, regarding the sampling, markers and statistical analysis.

Material and Methods

Sampling of animals of the two populations and DNA extraction

Buffaloes for genotyping were chosen in order to assure that they were a representative sample of the two populations. The sample of the Italian buffalo population analyzed in the present study was composed of 38 animals, 28 bulls in progeny testing, from 12 different farms located in six provinces and ten cows from different dams and sires of the research farm of the Ministry of Agriculture (Rome). The Greek population analyzed in the present trial consisted of 32 animals belonging to eight herds between which no exchange of breeding stock had occurred. Animals of each herd were chosen from different years of birth, to assure that they were born from different sires; in fact, it is common practice to use different breeding bulls every year.

DNA was extracted either from semen with the GENOMIX extraction kit (Talent, Trieste, Italy) or from frozen blood with the Qiagen extraction kit (Qiagen Gmbh, Hilden Germany).

Microsatellite polymorphism detection

From the set of microsatellites, which were shown to be polymorphic in cattle and buffalo (FAO, 1998; Moore *et al.*, 1995), nine, CSSM043, DRB3, CYP21, D21S4, CSSM38, CSSM47, CSSM60, CSSM36 and CSSM33 were preliminarily amplified with polymerase chain reaction (PCR) using primer sequences as suggested in literature (Moore *et al.*, 1995). For all microsatellites, except CSSM36, PCR

Figure 2. Italian lactating buffaloes at the paddock.

products were analyzed with seven percent denaturing polyacrylamide-sequencing gels. Visualization was achieved by the silver staining procedure (Comincini *et al*., 1995). Allele sizes were determined by comparison with a ten bp sequencing ladder (Life Technologies, TM). Microsatellite CSSM36 was analyzed for all samples, with a Perkin Elmer ABI Prism 310 Genetic Analyzer, purchased during the trial, using the Genescan software (Perkin Elmer) which detects different alleles by comparing sizes with standard DNA sizes (Tamra, Perkin Elmer).

Statistical analyses

Allele frequencies and mean heterozygosity estimates for each population were obtained using the FSTAT programme (Goudet, 1995). Average gene diversity at each locus was calculated according to Nei's formula (Nei, 1973), for each population separately and for the two populations together. Average gene diversity across loci was regressed on the number of alleles at each locus, as in Barker *et al*. (1997).

Wright's fixation indices (Wright, 1943 and 1951) were computed using the FSTAT programme to assess genetic differentiation of populations. They represent the probability that two alleles chosen at random within the same population in generation *t* are identical by descent. F_{it} is the fixation index calculated for the total population, a measure of the global heterozygosity deficit (total inbreeding) (Barker *et al*., 1997); F_{st} is the fixation index calculated for each of the two sub-populations, a measure of the between populations heterozygosity deficit and F_{is} is a measure of the within population heterozygosity deficit (inbreeding).

Table 1. Number of microsatellite alleles at each locus in Italian and Greek buffaloes, and number of shared alleles between the two populations.

Locus	Numbers of alleles			
	Total	Italian population	Greek population	Shared
CSSM43	4	2	4	2
DRB3	9	9	5	5
CYP21	4	4	4	4
D21S4	2	2	2	2
CSSM38	6	5	5	4
CSSM47	13	7	12	6
CSSM60	8	6	7	5
CSSM36	6	4	6	4
CSSM33	3	3	3	3
Mean	6.1	4.6	5.3	3.9

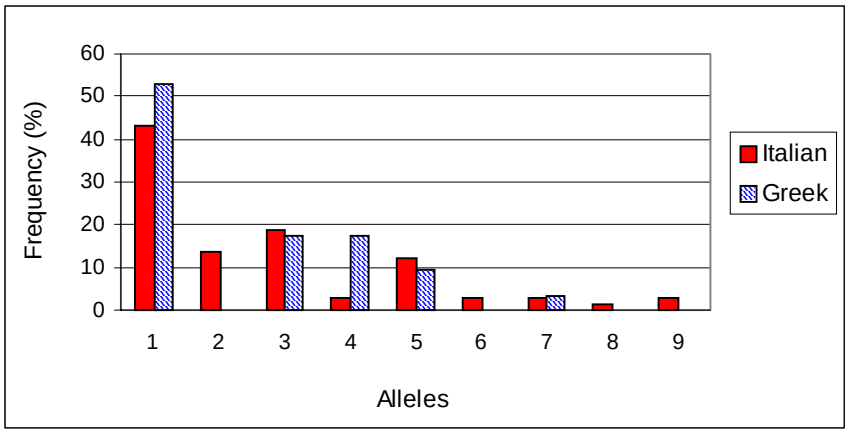

Figure 3. Allele frequencies at locus DRB3.

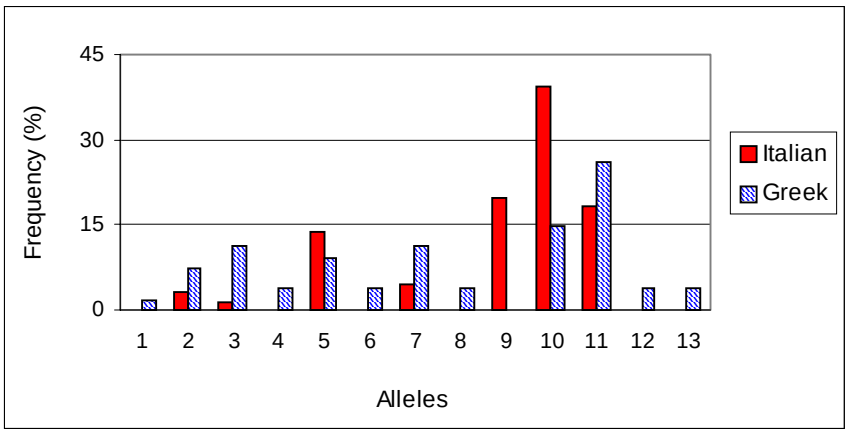

Figure 4. Allele frequencies at locus CSSM47.

Table 2. Allele frequencies (%) of the anaysed microsatellites in the two populations.

		Alleles												
Locus	Population	1	2	3	4	5	6	7	8	9	10	11	12	13
CSSM43	Italian		9.2		90.8									
	Greek	10.9	15.6	3.1	70.4									
DRB3	Italian	43.2	13.5	18.9	2.7	12.2	2.7	2.7	1.4	2.7				
	Greek	53.1		17.2	17.2	9.4		3.1						
CYP21	Italian	45.0	30.00	20.0	5.0									
	Greek	33.3	26.2	38.1	2.4									
D21S4	Italian	32.3	67.7											
	Greek	34.5	65.5											
CSSM38	Italian	13.2		11.8	2.6	21.1	51.3							
	Greek	25.8	1.6		1.6	33.9	37.1							
CSSM47	Italian		3.0	1.5		13.6		4.5		19.7	39.5	18.2		
	Greek	1.9	7.4	11.1	3.7	9.3	3.7	11.1	3.7		14.8	25.9	3.7	3.7
CSSM60	Italian	12.1		3.0	18.2	4.5	34.9	27.3						
	Greek	24.2	8.1	14.5	9.7		16.1	25.8	1.6					
CSSM36	Italian	14.9	6.8		56.8	21.5								
	Greek	20.7	5.2	10.3	48.3	13.8	1.7							
CSSM33	Italian	81.7	5.0	13.3										
	Greek	80.7	4.8	14.5										

Table 3. Average gene diversity.

Locus	Italian Population	Greek Population	Total
CSSM43	0.167	0.469	0.320
DRB3	0.741	0.649	0.712
CYP21	0.665	0.675	0.682
D21S4	0.437	0.452	0.444
CSSM38	0.660	0.680	0.686
CSSM47	0.751	0.866	0.835
CSSM60	0.754	0.812	0.801
CSSM36	0.603	0.691	0.650
CSSM33	0.312	0.327	0.320
Mean/locus	0.565	0.624	0.605

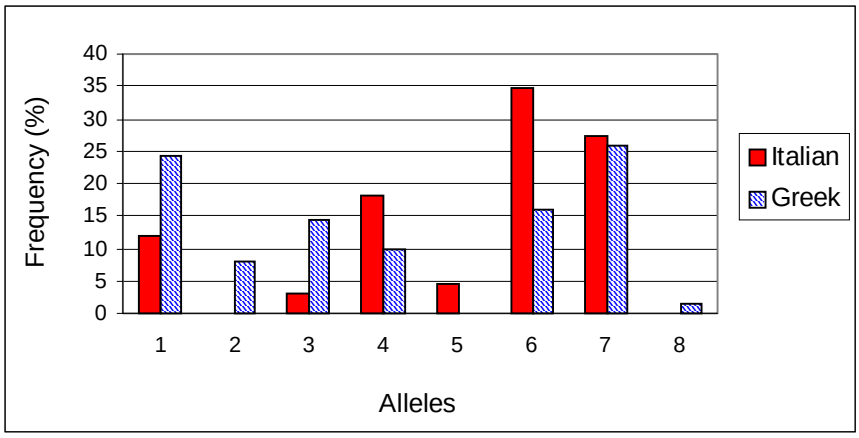

Figure 5. Allele frequencies at locus CSSM60.

Results

In table 1, allele frequencies for each of the nine microsatellite loci in each of the two populations are reported. The number of alleles per locus varied from two (D21S4) to thirteen (CSSM47). Only for three loci, CYP21, D21S4 and CSSM33, were all detected alleles found in both Italian and Greek buffaloes. The mean number of alleles per locus is slightly lower in the Italian groups (4.6) than in the Greek (5.3). In DRB3 locus, nine alleles were found in the Italian population, while in the Greek samples four of them were not detected (Figure 3). Conversely, in CSSM43 locus, four alleles were found in the Greek population of which only two were detected in the Italian one.

Allele frequency distribution at the nine analyzed loci is given in table 2. For six loci (CSSM43, CSSM38, DRB3, D21S4, CSSM36 and CSSM33) the same alleles are at the highest frequency in the Italian and Greek populations. At locus CYP21, the two populations showed consistent frequencies, although different, at loci 1, 2 and 3, while both of them have a very low frequency at locus 4. Locus CSSM47 is the most polymorphic, especially in the Greek population (Figure 4), followed by DRB3 (Figure 3) and CSSM60 (Figure 5).

Average gene diversity (Nei, 1973) over all loci in the two populations was 0.605, while for individual loci average gene diversity ranged between 0.320 (CSSM43; CSSM33) and 0.835 (CSSM47) (Table 2). Across loci, average

gene diversity increases by the number of alleles (regression co-efficient = 0.03±0.01, $P<0.05$).

Observed heterozygosity averaged on all loci was 0.167 for the Italian and 0.177 for the Greek population. It was insignificantly lower than the expected heterozygosity (0.222 and 0.247, respectively for the Italian and the Greek).

Estimated means of the total fixation index separately for the two populations were 0.350 for the Italian and 0.242 for the Greek, indicating that the Italian population is more inbred.

Estimated mean for F_{st} (differentiation between Italian and Greek buffalo) was 0.021±0.009. The overall estimate of inbreeding co-efficient was 0.313±0.054.

Discussion

This is the first study on the genetic diversity of buffalo populations in Europe and the Near East, which are all considered to be of the Mediterranean type on the basis of their phenotype and performances where the results provide an indication on the feasibility of the methodology and give a preliminary description of some loci.

Observed heterozygosity (0.167 for the Italian and 0.177 for the Greek buffaloes) was not significantly different from the expected under the random mating assumption in either population (0.222 for the Italian and 0.247 for the Greek buffaloes). The lower values of the observed and expected heterozygosities, compared to the values found by Barker (1997) for river buffaloes in Asia (0.558 and 0.579), confirm that a considerable loss of biodiversity in buffalo has occurred in Europe, as a consequence of the decline in numbers and increased inbreeding.

Differentiation of the Italian and Greek buffaloes (0.021) resulted in even lower than the average differentiation (0.038) that Barker (1997) found between three different river buffalo populations, South Sri Lankan, Sri Lankan Murrah and Malaysian Murrah. Considering that the value of differentiation between swamp type buffalo obtained by Barker (1997) was much higher (0.178) and that rates up to 0.15 indicate moderate differentiation between populations (Hartl, 1980), the obtained results (0.021) suggest that there is a need to investigate more thoroughly the genetic differences between the two populations through the analysis of further loci.

The Greek population seems to have a lower rate of inbreeding (0.242) in spite of its small size compared to the Italian (0.350), which may be explained by the absence of any directional selection. In addition, the expected heterozygosity in the Greek population is higher than in the Italian, indicating that the population has retained the presence of several alleles, although at a small frequency. This implies a higher amount of genetic variability that might be used in planning breeding strategies and can be exploited particularly in populations of small size. Furthermore, such variability could also be employed to detect genetic markers that might be linked to quantitative trait loci (QTL).

In order to have a better picture of the genetic diversity of the considered populations and to accurately estimate the diversity parameters when more than two populations are analyzed, FAO (1998) suggested that the number of polymorphic loci to be analyzed should not be less than 20. The present work will therefore be extended to include more microsatellite loci as well as other river buffalo populations.

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The Jakhrana Goat in India

B. Rai, S. Tiwari & B.U. Khan

*Central Institute for Research on Goats, **Makhdoom**, P.O. Farah-281 122, Mathura, India*

Summary

Jakhrana is an important dairy breed of the semi-arid tract of the Rajasthan State of India. The habitat of this breed is a small hamlet in the Aravali hill ranges. The breed is spread over a limited area and the population size is small. The breed is of medium size, with a predominantly black coloured coat with white spots on ears and muzzle. Body weight, body length, punch girth, heart girth and body height at 12 months of age were respectively, 30.9±1.7 kg, 69.5±1.9 cm, and 69.1±1.4 cm, 61.9±0.6 cm and 77.2±1.6 cm in males and 22.6±0.7 kg, 62.1±0.8 cm and 63.3±0.6 cm, 60.1±0.6 cm and 69.1±0.7 cm for the females. Pre-weaning and post-weaning body weight gains were higher in males. Overall milk yield in 181 days was 116 kg. Kidding rate was 75 percent in field conditions with a twinning percentage of 79.1 percent. The field survey on this breed indicated that the goats were managed in a traditional system. The goats were kept by the farmers to meet their nutritional as well as economic needs. The marketing of live goats and goat products had limitations. There is no breed conservation/improvement programme at the moment, this is urgently needed to improve this goat breed.

Resumen

La Jakhrana es una importante raza caprina de leche de la zona semi árida del Estado de Rajasthan en la India. El habitat de esta raza se encuentra en una pequeña aldea de las colinas de Aravali. La raza se extiende por una zona limitada y el tamaño de la población es bastante reducido. Esta raza es de tamaño medio, el color del manto es prevalentemente negro con manchas blancas en las orejas y hocico. El peso corporal, largura, cinchera, circunferencia torácica, y altura a los 12 meses son, respectivamente, de 30,9±1,7 kg, 69,5±1,9 cm, y 69,1±1,4 cm, 61,9±0,6 cm y 77,2±1,6 cm para los machos, y 22,6±0,7 kg, 62,1±0,8 cm y 63,3±0,6 cm, 60,1±0,6 cm y 69,1±0,7 cm para las hembras. La ganancia de peso corporal pre y post destete es elevada en los machos. La producción total por lactación de 181 días fue de 116 kg. Los partos tienen lugar en condiciones de campo en 75% de los casos, con una incidencia gemelar del 79,1%. Una encuesta realizada sobre el terreno sobre esta raza indicó que normalmente el sistema de conducción era tradicional. Los agricultores crian a los animales para cubrir sus necesidades nutricionales así como económicas. El mercado de animales vivos y de productos caprinos presenta ciertas limitaciones. No existe actualmente un programa de conservación/mejora de la raza; por lo que resulta urgente tomar medidas a este respecto.

Key Words: *Jakhrana goat, Management practices, Production performance.*

Introduction

Goats have played a very vital role for man since prehistoric times. They were probably among the first animals to be domesticated around 9000-7000 BC (Zeuner, 1963). There are 20 defined goat breeds in India which constitute 20-25 percent of the total goat population and the remaining 75-80 percent are of a non- descript type with variable features. Goats are one of the dependable sources of income and provide nutritional support to the people living in the arid and

semi-arid, hilly and tribal areas. Seventeen percent of the world and 26 percent of the Asian goat population are found in India alone (FAO, 1997), which contribute significantly to the income of poor farmers by production of meat, milk, skins and other by-products.

The Jakhrana breed of goats found in the Rajasthan Province of the country, is well known for their production potential all over the country. This breed is well-recognized as a dairy breed with a good record of milk production. The name of the breed derives from the name of a village called 'Jakhrana' where the goat with the highest concentration is found. Jakhrana village is located in Behror Tehsil region of the Alwar district in Rajasthan, however, the breed is also found in neighbouring areas. Due to its dark black colour, the breed is locally known as '*Kali kotri*'. A survey conducted in the breeding area of Jakhrana indicated that the average herd size was 5.5 does and 4.1 kids per herd. Almost 50 percent of the herds was kept under extensive systems of management. The goats are mainly kept in improvised thatched houses with mud floors (76 percent farmers). Grazing was mostly dependent on poor range lands and lopping of trees (*P. cinreria, Z. numularia*) due to the shortage of biomass in the grazing area most of the time. Crop stubbles and residues are the potential source of seasonal grazing. During inclement weather goats are also fed on straw, dry fodder and tree leaves along with small quantity of grains.

Population and Distribution

Rajasthan with 13 percent of the total goat population of India had 5.56 million goats in 1951 which increased to 15.31 million in 1992 as per the Livestock Census of India (1992). Jakhrana is a hardy goat breed well adapted to the semi-arid climatic conditions of Rajasthan. The breed is found in Jakhrana village and neighbouring areas near Behror in the Alwar districts of Rajasthan (Acharya, 1982). However, cross goats of this breed are also found in neighbouring areas. According to a rough estimate, the number of goats which are true to the breed is no more than 6 000. The total goat population of the Alwar district was 480 000 heads during the year 1988 (Census Report, 1988).

Climate/Adaptability

The agro-climatic conditions in the natural habitat of this breed is semi-arid with very low and erratic rain-fall. The Rajasthan State normally experiences an annual rainfall of 20 to 40 cm. However, in the home tract of the breed the average annual rainfall is 64.81 cm. The average temperature ranges between 8.3 and 40.6°C in this area (Acharya, 1982). During the rainy season good pastures are available whereas during the dry season only poor quality grazing is available and Jakhrana goats are well adapted to the semi-arid climatic conditions and thrive on such poor quality grazing. The natural habitat of this breed has sandy soil, lower water level and intermittent dry spells. Due to the climatic and soil conditions, agricultural activities are limited during the year. The grazing area for goats includes forest, wasteland and hillocks where trees and bushes are scanty.

Management Practices

A pilot study conducted during the year 1993-94 in the home tract of the Jakhrana breed revealed that extensive management systems (48 percent) prevailed in village conditions followed by semi-intensive (31 percent) while 20 percent of the goats are mainly kept in intensive systems, including breeding bucks and high yielding does**.** No specific housing is provided in this area. Only improvised thatched housing was provided by 76 percent of the goat keepers whereas 23 percent of the goats was kept in the family houses. The flooring of houses was mud based (*Kachcha*) in all cases. The goats were let out for grazing in the field but due to lack of biomass (bushes and grasses) the lopping of fodder trees was adopted. The grazing hours were limited to 5.4 hours per day. Goats were preferably grazed by old people (79 percent)

Table 1. Management practices in the home tract of Jakhrana Goats (Khan, 1994).

Practice	Respondents (N = 68) (percent)
Management system	
Extensive	48
Intensive	20
Semi-Intensive	30
Housing	
Thatched house	76
Improved Shed	0
Own House	23
Floor	
Mud based (Kachcha)	100
Pacca	---
Grazier	
Ladies	4
Children	0
Old person	79
Additional Feeding	
Leguminous Fodder (Gwar)	26
Straws (Gram + Gwar)	14
Tree leaves	25
Cooked millets (Dalia)	19
Concentrate	5
*Sale of Goats**	
Kids	Rs. 400 / kid
Adult	Rs.1500 / goat

**Sale prices are based on the year 1993-94.*

in the village. Additional feed was provided to the goats in the form of leguminous fodder (46 percent), straw (15 percent), tree leaves (25 percent) and dalia (cooked millets) by 19 percent of the goat keepers (Table 1). However, concentrate was provided by only six percent of the respondents. The sale of the goats was made in the village itself, although this fetched lower prices (Rs. 400 / per kid, Rs.1500 / per adult goat) due to middleman intervention in the sale / purchase system. The study indicated that the Jakhrana goats were managed under the traditional management system. It is necessary to popularize scientific rearing methods in field conditions to increase the production of the goats (Khan, 1994).

Phenotypic Characters

The animals of this breed are fairly large in size with narrow forehead and raised faces. Legs are long with a deep and compact body. The udder is well developed with long and conical teats. The coat colour is predominantly black with white spots on the ears and muzzle (Figures 1 and 2). The coat is short and lustrous. The face line is straight with shining eyes. Ears are of medium size and drooping in most cases. Both sexes are horned, males had comparatively thick horns directed upwards. The adult body weight of the male and female were 57.8±3.5 kg and 44.4±0.5 kg, respectively (Acharya, 1982).

Body size

The mean values of body size in terms of body length, heart girth, paunch girth and body height is presented in table 2. It is noted that all the measurements in the males had higher values than the females at all ages.

Body weights

The average mean body weights at birth, 3, 6 and 12 months of age were 2.7±0.1, 11.9±0.6, 17.3±0.5 in males and 2.4±0.1, 10.4±0.6, 15.7±0.5 and 22.6±0.7 kg in females, respectively (Table 3). The body weights of adult bucks and doe were recorded as 57.8±3.5 kg and 44.4±0.5 kg, respectively. The pre-weaning growth (0-3 months) was higher in males and female kids as compared to post-weaning growth (Table 4).

Reproduction and Breeding

A pilot survey conducted in the breeding tract of the Jakhrana goats indicated that May and June were the pronounced season of breeding which resulted in 83.3 percent kidding during

Table 2. Body measurements(cm) of Jakhrana goats (Anonymous, 1994).

Age group	Body length		Heart girth		Paunch girth		Body height	
	Male	Female	Male	Female	Male	Female	Male	Female
At birth	29.9±0.2 (92)	29.0±0.3 (83)	35.3±0.3 (92)	34.2±0.3 (83)	29.2±0.2 (92)	28.2±0.2 (83)	35.3±0.3 (92)	34.2±0.3 (83)
3 month	50.5±0.9 (80)	49.9±1.0 (79)	55.3±0.9 (80)	53.0±0.9 (79)	49.8±1.0 (80)	48.3±0.9 (79)	55.3±0.9 (80)	53.0±0.9 (79)
6 month	57.5±0.6 (64)	55.8±0.6 (43)	61.9±0.6 (64)	60.1±0.6 (43)	55.9±0.4 (64)	55.0±0.5 (43)	61.9±0.8 (64)	60.1±0.6 (43)
12 month	69.5±1.9 (4)	62.1±0.8 (27)	77.2±1.6 (4)	69.1±0.7 (27)	69.1±1.4 (4)	63.3±0.6 (27)	77.2±1.6 (4)	69.1±0.7 (27)

Figures in parentheses indicate the no. of observations.

Table-3. Body weight (kg) at different ages in Jakhrana Goats (Anonymous, 1994).

Parameter	No.	Male	No.	Female
Birth weight	92	2.7±0.1	83	2.4±0.1
Weaning weight	80	11.9±0.6	79	10.4±0.6
6 Months weights	64	17.3±0.5	43	15.7±0.5
12 Months weight	04	30.9±1.7	27	22.6±0.7

Table 4. Body weight gain (gm/day) in Jakhrana Goats (Anonymous, 1994).

Parameter	No.	Male	No.	Female
Pre-weaning (0-3 Month)	84	100±8.0	85	70±7.0
Post-weaning (3-6 Month)	05	65±4.3	31	45±1.8

October (Table 1). The kidding rate in field conditions was 75 percent, the twinning percent was quite high (79.1 percent) in comparison to single (16.6 percent) and triplet (4.1 percent). The age at first kidding was 574±45 days in farm conditions, however, Acharya (1992) reported a lower estimate (316±51 days). Kidding interval was 319.2±12.2 days in farm conditions (Table 5). These estimates indicated that Jakhrana is a prolific breed and there is a fair scope to improve its breeding efficiency further in field / farm conditions of management.

Production Performance

Milk production performance of Jakhrana goats is presented in table 5. The part lactation yield of 90 days and 150 days was 74±2 kg and 101.5±3 kg, respectively in farm conditions. Milk yield was 116±3 kg in a lactation length of 181±4 day. The peak yield

Figure 1. Jakhrana buck.

Figure 2. Jakhrana doe.

Table-5. Production characteristics of Jakhrana goats (Anonymous, 1994).

Parameters	No.	
Age at first kidding (day)	6	574±46
Weight at first kidding (kg)	89	34.8±0.5
Kidding interval (day)	42	319±12
90 days milk yield (kg)	89	74±2
150 days milk yield (kg)	79	101±3
Lactation milk yield	89	116±3
Lactation length (day)	89	181±4
Peak yield (kg)	89	1.2±0.0
Peak week	89	2.81±0.3

was 1.2±0.1 kg in farm conditions. Acharya (1982) reported higher lactation yield in this breed. The milk yield in village conditions was higher and the highest yield was recorded as 3.5 kg per day. This was due to individual attention paid to care and feeding of the goats.

Survivability and Disease Resistance

A study was conducted at CIRG, Makhdoom on Jakhrana kids (298) to assess their adaptability and survivability in semi-arid conditions of India. The results indicated that mortality in kids was 1.6 percent per annum. The major causes (81 percent) for mortality were pneumonia, colibacillosis, toxaemia, pneumoenteritis and coccidiosis. The least square analysis of variance revealed that birth weight and season of kidding had a significant effect on mortality. Findings further revealed that this breed is well adapted to semi-arid climatic conditions (Goel *et al.*, 1997).

Improvement Programme

Little effort has been made to improve this goat breed. Production performance was evaluated in a closed flock maintained at CSWRI Avikanagar, Rajasthan under the auspices of the All India Coordinated Project on Goats (AICRP). Results accrued from AICRP on goats indicated that this breed had a considerable production potential for milk and meat production in semi-arid climatic conditions. Jakhrana goats have been introduced in different places and buck are used for upgrading the local goats for increasing milk production. Since this breed has been enlisted as endangered, it needs more concerted efforts towards conservation as well as improvement. There is an urgent need to launch an effective breed improvement programme in the home tract of the breed with the help of national and international collaboration. In general NGOs can play a vital role in the breed development programmes in India as their role in goat improvement has been commendable in the Maharashtra and Rajasthan States particularly to improve Osmanabadi and Sirohi goats, respectively.

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