

The development and maintenance of animal recording systems in Greece: a case study

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Summary

Animal performance recording and breeding in Greece aim at improving milk production of pure-bred cattle under intensive systems and of sheep and goats under semi-intensive or extensive production systems. Although milk recording was established in Greece by the Ministry of Agriculture in 1952, it is only since 1978 that it has been carried out more systematically on larger populations and in the frame of a more specific genetic improvement programme for each animal species and breed. For the application of this programme, close co-operation has been set up among the competent services of the Ministry of Agriculture, the Agricultural Universities of the country and the relevant farmers' organisations which are in the process of being established. Milk is recorded on 61 867 dairy cows (29% of the total dairy population) in 1 425 herds (average herd size 43 cows), 31 611 dairy sheep (0.36% of the total sheep population) in 429 flocks (average flock size 72 ewes) and 3 296 goats (0.06% of the total goats population) in 36 flocks (average flock size 92). The procedures of performance recording and the future planning, aiming at increasing the number of animals and the recorded traits as well as the supporting of the farmers in managing their herds/flocks, are presented.

Résumé

En Grèce le contrôle laitier et l'élevage visent à l'amélioration de la production du lait de bovins de race pure sous des systèmes de production intensifs et des ovins et caprins sous des systèmes de production semi-intensifs ou extensifs. Quoique le contrôle laitier a été fondé en Grèce par le Ministère de l'Agriculture en 1952, seulement depuis 1978 celui-ci a été porté plus systématiquement sur des populations plus larges et dans le cadre d'un programme d'amélioration génétique pour chaque espèce et race animale plus spécifique. Pour l'application de ce programme, une co-opération étroite a été initiée parmi les services compétents du Ministère de l'Agriculture, les Universités d'Agronomie du pays et les organisations des éleveurs pertinentes qui sont en cours d'être établies. Il existe 61 867 vaches laitières en contrôle (29% de la population laitière totale) dans 1 425 troupeaux (taille moyenne du troupeau 43,4 vaches), 31 611 brebis laitières (0,36% de la population ovine totale) dans 429 troupeaux (taille moyenne du troupeau 71,7 brebis) et 3 296 chèvres (taille moyenne du troupeau 92,5 chèvres). On présente le processus du contrôle de performance et les plans futurs ayant pour but d'augmenter le nombre des animaux et les caractéristiques

contrôlées, ainsi que d'offrir aux éleveurs le soutien nécessaire pour la gestion de leurs troupeaux.

Key words: Recording schemes, Data processing, Computerisation.

Brief Characterisation of the Animal Recording System

Species and breeds involved. Number of herds/flocks and animals recorded

The bovine population in Greece has changed rapidly during the last 35 years. The number of cattle has decreased from 1 131 000 animals in 1965 to 608 000 in 1993. In 1996 the number of dairy cows is estimated at 216 000 head, 94% of them being Holstein-Friesian. Only 29% of these dairy cows are recorded (Table 1; Georgoudis, 1988; Baltas, 1995).

The present total sheep population is 10 069 million animals in 153 000 flocks. About 80% of this population consists of crossbred sheep and are found in every part of the country. Most of these animals are the result of a long-term and uncontrolled crossbreeding. The major segment of the sheep population belongs to the Zackel type, which is found all over the country and is characterised by the long tail and the coarse wool. A second segment of breeds belong to the Ruda type, with finer and more uniform wool and is found mainly in Macedonia, Thrace and on some Aegean islands. A third category consists of the so-called semi-fat-tailed type, found on East Aegean islands. Although all of the above breeds can be broadly classified as dual-purpose sheep (milk and meat), the second and third categories include breeds combining high prolificacy and milk yield (Table 1; Boyazoglu, 1991a; Zervas *et al.*, 1991).

The present goat population in Greece numbers 5 821 000 animals, of which 90% belong to various indigenous types. These local breeds represent about 4.5 million head

in 200 000 flocks. The local goat is to be found over the entire country and derives its name from the particular region. Great interest is being attracted to the Skopelos goat (Table 1; Hatziminaoglou *et al.*, 1985; Baltas, 1995).

Overall input level of the production environment

Dairy cattle are kept in environments which range from the upper medium to high level of inputs. Nevertheless, in Greece the general purposes, procedures and conditions for recording are the same for all species and breeds (Georgoudis, 1988; Baltas, 1995).

Sheep population is characterised by specific breed structure and husbandry methods. A large number of sheep-producing units are composed of a small number of animals per flock. In fact, 60% of all flocks include ≤ 50 ewes, which shows that they are of complementary importance to other agricultural production activities. The major animal production activity is milking, followed by meat from young lambs slaughtered after early weaning at 40 to 60 days. Complementary feeding during the last part of pregnancy and the suckling period (with the exception of some semi-intensive or housekept flocks on the plains) and the application of a transhumance are characteristic of most of the major extensive flocks (Boyazoglu, 1991a and b; Zervas *et al.* 1991; Baltas, 1995; Ligda *et al.*, 1997).

Goat production has always been practised, to a large extent, within a particular socio-economic and spatial context. It generally concerns infertile, mostly degraded areas, which only the forest could have eventually made economically viable. Very extensive husbandry systems are applied to the local breeds, which play a major role in the rural economy of the difficult mountainous and semi-mountainous regions of the country. Extensive grazing conditions are, thus, put to value, which would not otherwise be of use (Hatziminaoglou *et al.*, 1985).

Table 1. Dairy, sheep and goats' milk recording in Greece: Populations, number of recorded animals and herds/flocks.

Species and breeds	Total population	Recorded animals (percent recorded)	Total herds/flocks	Recorded herds (% recorded)
<u>Dairy cow breeds</u> (data from 1996)	216 000	61 867 (28.6%)	n.a.	1 425
Holstein Friesian	203 000	61 508 (30.3%)	n.a.	1 411
Brown Swiss	13 000	225 (1.7%)	n.a.	9
Simmental	n.a.	134	n.a.	n.a.
<u>Sheep breeds*</u> (data from 1994)	561 800	31 611 (5.6%)	8 645	429 (5.0%)
Mountains of Epirus (Boutsiko)	28 700	2 450 (8.5%)	300	24 (8.0%)
Sfakion	75 000	1 650 (2.2%)	1 050	20 (1.9%)
Karagouniko	208 000	14 800 (7.1%)	3 210	210 (6.5%)
Serres	38 000	2 200 (5.8%)	670	32 (4.8%)
Frisarta	27 800	5 011 (18.0%)	835	73 (8.7%)
Chios (purebred)	7 300	1 000 (13.7%)	350	10 (2.9%)
Lesvos	177 000	4 500 (2.5%)	2 230	60 (2.7%)
<u>Goat breed**</u>	8 000	3 296	n.a.	36
Skopelos (data from 1994)	8 000	3 296 (41.2%)	n.a.	n.a.

* only for the breeds mentioned in the table. For the total sheep population see table 2.

** local goat populations are not controlled.

Animal categories involved in the recording process

In each controlled herd/flock, all females (cows/ewes/goats) and subsequently all their female progenies (calves/lambs/kids) which are maintained as replacements, are involved

in the recording process. Performance recording on the Agricultural Research Stations involves all the animals in the flock (sheep, goats only), which are considered as breeding nucleus for the genetic improvement of the relevant breed.



Figure 1. A flock of milk-recorded Skopelos goat breed (Animal Genetic Improvement Centre of Karditsa).

Purpose(s) of the scheme

In general, cattle, sheep and goat performance recording aims at genetic improvement through mass selection milk production and estimating the necessary genetic parameters for milk yield, needed for the operation of the genetic improvement scheme. Two types of recording schemes are recognised. On-farm and on-station performance recording.

On-farm performance recording for dairy cattle, sheep and goats was conceived to provide, firstly, data for the genetic improvement of the animals and secondly, to supply management and technical information for the farmers.

For cattle, no progeny testing or family selection has been applied until now. The lactation data collected by the recorders are processed by computers and the information on the 305-day and total lactation is sent to

the farmers who use it for selection. The AI bulls, which are all imported and progeny tested in other countries (USA, France, Germany, etc.), are chosen by the farmers according to their breeding value calculated abroad. Models for the calculation of the breeding value of the recorded cows and their progenies, by BLUP-Animal Model methodology are routinely prepared, but not yet fully utilised in the everyday practice (Georgoudis, 1988; Georgoudis *et al.*, 1992).

Performance recording in the Agricultural Research Stations aims at collecting data for studying the various native sheep and goat breeds of the country and is carried on without the involvement of the livestock keepers. These institutions are supervised by the National Foundation for Agricultural Research.

Regarding sheep and goats which are recorded on field, the farmers also receive the calculation of the total lactation for each

animal, based on individual recordings. With these data the farmers can select only the best females, because there is no information on the males. There are two exceptions to this situation. Since 1986, an attempt has been made to implement a progeny testing scheme for the rams of the Karagouniko breed in Thessaly. Actually, this programme has not been applied continuously because of the lack of personnel (milk recorders) and the existence of serious problems regarding the organisation of the AI. The other exception is the performance recording of the Agricultural Research Station in Chalkidiki, where a programme has been recently started to utilise the Chios sheep of the Station as a nucleus for the breed, by applying an index selection and disseminating genetically superior male and female animals to commercial flocks (Gabilidis, 1993; Baltas, 1995; Georgoudis *et al.*, 1995; Ligda *et al.*, 1997).

Animal identification

Identification is made by plastic eartags. This unique official number actually consists of two sets of digits, namely the herd number and the number of the animal made up of the year of birth and an in-herd running animal number. Identification for milk recording and A.I. applied for genetic improvement in cattle, are identical. Furthermore, the Greek Veterinary Service is using for all species a second plastic eartag aiming at the identification of the animals for health purposes.

Traits measured

The traits considered and the collected information are:

1. Individual identification of all animals.
2. Mating and lambing/kidding dates and consecutive number.
3. Type of birth, sex of the lambs or kids and litter size.
4. Monthly controls of milk yield (a.m. and p.m.) after the suckling period.
5. Fat, protein and lactose content of milk.

6. Live weight records of lambs at regular intervals (birth, before and after weaning).
7. Live weight records of ewes at mating and at lambing.

Actually, some of these traits (traits 5, 6 and 7) are not regularly recorded on the field (Georgoudis, 1988; Gabilidis *et al.*, 1993; Baltas, 1995; Ligda *et al.*, 1997).

The method of milk recording is the official A1, once a month two milkings per day. The controller records for each ewe in his first visit after lambing/kidding, the identification number, the age in years, the data and the consecutive number of the lambing/kidding, the number and the sex of the lambs/kids born alive (after the first 24 hours). The visits are repeated once a month and the milk yield is measured in the first visit after the suckling period. Measurement takes place by a volumetric tube with markings of 1/100 lt. This is done until the end of the lactation period of each ewe/goat, that is when daily milk drops under 0.05 lt (~ 50 g). The collected data with a sample for measuring the milk contents is delivered immediately after the visit to the responsible body, the Animal Genetic Improvement Centre (Georgoudis, 1988; Baltas, 1995).

Other information collected

Information regarding feeding or health traits is not collected. Pedigree information derives, when properly registered, from the individual identification and lambing data. No efforts have been made until now to collect and analyse information related to herd/flock management.

Types of analysis of samples and processing of data

Analysis of samples and processing of data are not undertaken on the farms. Milk samples are analysed at the Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athens) with two MILKOSCAN apparatuses in each Centre (type 104 without printing and 133 with printing device), capable of measuring fat,

protein, lactose and solids with and without fat, at the rate of 700 samples per hour. After milk content is determined, the results are matched with milk recording data and finally sent for processing to the central computer. The trend is moving towards storing and processing the collected data at local PC's (in one Animal Genetic Improvement Centre it has already been done) (Baltas, 1995).

Computerisation and storing of the data

The processing of the data is accomplished centrally. At the beginning of the implementation of animal recording a small-scale computing centre was established in co-operation between the Ministry of Agriculture and the Department of Animal Husbandry - Laboratory of Animal Genetics and Breeding of the Aristotle University of Thessaloniki, at the University Farm.

This computing centre provides facilities for processing milk and reproduction control data collected in northern and central Greece, where the major part of the dairy cattle population is kept. In the meantime, part of the processing work is accomplished by personal computers in the Animal Genetic Improvement Centre using home made software (Georgoudis and Alifakiotis, 1985; Georgoudis, 1988).

The method applied for the calculation of marketable milk production of the ewes and goats controlled is the Fleischmann, modified to accomplish a 42, instead of 24 day suckling period.

Processing for the cattle recording data takes place every month and the results are sent back to the farmers. At the present time, processing for sheep and goats is accomplished once, at the end of the production period and the advice to the farmers is based on the results of the total lactation of each ewe/goat and the average production, as well as the standard deviation of the flock in relation to the average and standard deviation of the whole region for which the Animal Genetic Improvement Centre is responsible (Georgoudis, 1988).

Government and farmers' involvement

The Greek Ministry of Agriculture is responsible for the proper implementation of the on-farm performance recording. A basic adverse factor for the promotion and improvement of the animal recording and the livestock structure in general, has been the absence of organised initiative on the part of the livestock breeders. As a consequence, there are no genealogical books belonging to farmers' organisations.

The difficulties of the implementation of the recording system are not counterbalanced by an individual and collective interest in the results provided. Furthermore, a degree of breeders' resistance to recording is noticed because of the tedious work involved in milk sampling and weighing. Also, the discussions for passing at least a part of the recording cost on to the farmers do not help its further development. To overcome these constraints, the current trend is to simplify the recording and to accelerate data turnaround (Baltas, 1995).

Who pays for the recording

The responsibility for the on-farm performance recording has been exclusively undertaken by the Ministry of Agriculture and the financial support comes from the Greek government. Performance recording on the Agricultural Research Stations is supervised by the National Foundation for Agricultural Research, which indirectly receives financial support from the Ministry of Agriculture.

Furthermore, during the previous periods (since 1993), the Ministry of Agriculture granted the farmers considerable premiums to join the recording and genetic improvement scheme (Baltas, 1995).

Type and nature of technical support

The recording and genetic improvement scheme is scientifically and technically supported by the Ministry of Agriculture and the Agricultural Universities.

The Directorate for Inputs to Animal Production which is responsible for the Animal Genetic Improvement in the Greek Ministry of Agriculture, operates five regional Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athens). These Centres monitor the milk recording and genetic improvement scheme, process and evaluate the collected data in collaboration with the Animal Production Department of the University of Thessaloniki, inform the producers on the relevant results and provide them with technical advice on selection, breeding and feeding. Further technical advice to farmers is also given by

the Regional Agricultural Development offices of the Ministry of Agriculture (Georgoudis, 1988; Baltas, 1995).

Principal people involved in the development and maintenance of the scheme

The Ministry of Agriculture, Directorate for Inputs to Animal Production with five regional Animal Genetic Improvement Centres. The Agricultural Universities (Thessaloniki and Athens) have been involved in the development and continue to support the scheme with computer facilities, software for processing the collected data and scientific methodology for the genetic evaluation of the recorded populations (Georgoudis, 1988; Baltas, 1995;).



Figure 2. A flock of milk recorded Karagouniko sheep breed (Animal Genetic Improvement Centre of Karditsa).



Figure 3. Ewe of Chios breed with its lambs (Agricultural Research Station of Halkidiki).

Main Reason for Introducing and Maintaining the Scheme

The official animal performance and especially milk recording has been applied in Greece for about 50 years and it can be divided in four periods.

The first period, which could be characterised as an introductory one, covers the years between 1952 and 1962, when milk recording was planned by the regional services of the Ministry of Agriculture and intended to identify only the variability of milk yield of sheep raised in farms, without being an integral part in the framework of a genetic improvement programme of the known breeds. Generally, this period could be characterised as an introductory one, without a well-founded organisation and with a lot of omissions in milk recording and data processing. An exception to this was the recording applied in a considerable number of the Chios breed sheep on the homonymous

island. Related activities have also taken place in livestock research Institutes, though these Institutes did not and still do not participate in the official recording and genetic improvement scheme.

The second period covers the years from 1963 to 1977 and is characterised by the issuing by the Ministry of Agriculture of the relevant decisions and regulations for the organisation and operation of the herd book and milk recording of the common cattle, sheep and goat dairy breeds. Milk recorders were employed by the regional services of the Ministry of Agriculture in order to carry out milk and fat content recording, body conformation measurements, collection of feed intake information and processing of the data. Generally, the performance recording scheme was well and systematically organised, but the number of recorded animals was limited and the collected data were not being evaluated and used properly, mainly due to the lack of scientific and technical personnel.

The third period covers the years from 1978 to 1992 and is characterised by the establishment in the Ministry of Agriculture of the Directorate of Animal Genetic Improvement (later renamed Directorate for Inputs to Animal Production) and of five regional Animal Genetic Improvement Centres (Drama, Thessaloniki, Karditsa, Ioannina, Athens), which monitored the milk recording and genetic improvement scheme, processed and evaluated the collected data. In 1978 and 1982 the regulation of animal milk recording of 1963 was amended, as well as the relevant decision concerning the organisation and operation of herd book (Giossis, 1988).

The genetic improvement scheme, which has been introduced since 1978 and also applied during the period that followed, was based on the use of imported frozen semen from progeny tested bulls. This semen is used by the AI to service only cows participating in the milk recording scheme. Bulls, born by the best of these recorded cows, are bought by the AI service in order to cover the frozen semen needs for the rest of the dairy cow population. In 1987 the Department of Animal Production of the Faculty of Agriculture of the Aristotle University of Thessaloniki started to evaluate the imported progeny-tested sires with a BLUP model. In 1992 the evaluations extended to cover also the recorded cow population with an Individual Animal Model based solely on milk yield and performed twice yearly (Georgoudis and Alifakiotis, 1985; Georgoudis, 1988; Georgoudis *et al.*, 1992).

The fourth period, which is a continuation of the previous period, started in 1993 and has not yet concluded. In this period, the Ministry of Agriculture is also still in charge of the organisation and operation of milk recording and herd book keeping, but the intention is to totally involve the co-operative organisations, under the supervision of the Ministry (Baltas, 1995).

Most Significant Activities and Design Peculiarities That Have Enabled the Scheme

Initiation

The genetic improvement scheme, which has been introduced since 1978 and with minor modification being carried out until today, is characterised by the establishment in the Ministry of Agriculture of the Directorate of Animal Genetic Improvement and of five regional Animal Genetic Improvement Centres. These Centres monitor the milk recording, process and evaluate the collected data in collaboration with the Animal Production Department of the University of Thessaloniki and informed the producers on the relevant results. The Ministry of Agriculture is still in charge of the organisation and operation of milk recording and herd book keeping, but there is the intention to totally involve the co-operative organisations, under the supervision of the Ministry (Baltas, 1995; Georgoudis, 1988).

Maintenance

During the recent period milk recording was carried out more systematically, on a larger scale and in the framework of a more specific genetic improvement programme for each animal species and breed. A number of milk recorders has been employed, but they were not enough to cover the needs of the milk recording programme. Furthermore, a close co-operation has been established between the competent services of the Ministry of Agriculture and the Animal Production Department of the University of Thessaloniki. The use of computers has been started and as a result, the whole programme has improved, as far as the collection, evaluation and use of all the relevant data by the farmers and the responsible scientists are concerned. In addition to the milk yield, data on milk composition and those related to artificial insemination and parturition are being collected (Baltas, 1995).



Figure 4. A typical dairy cattle unit under milk recording (Animal Genetic Improvement Centre of Diavata).

Problems and Short Comings

The controllers' working conditions are very hard, especially when they are working with small ruminant producers, because the installations are very little improved or primitive. The identification of the animals has proved to be very difficult in flocks with a very large number of animals.

The Animal Recording and Genetic Improvement Centres are staffed with a small number of scientists and supporting personnel, resulting in a small proportion compared to the number of controlled animals. Taking into account that the production units are spread out over long distances, it is understandable that monitoring the controllers' work is difficult and the farmers are very often not consulted.

Accuracy of the collected data is crucial for animal recording schemes and great efforts have been made in order to secure this. For this to be accomplished, it is very important to hire controllers through an appropriate

procedure. In Greece, the animal recording scheme does not dispose of vehicles, so the controllers are obliged to use their own cars, taking a reimbursement per kilometre covered. The applied recording scheme implies that the controller visits twice (in the evening and the morning of the next day) each farm, having as a consequence very high travel costs and dead hours between these visits.

The actual computer processing is mostly the easiest part today as computers are generally sufficiently powerful. Efficient organisation of input to the computer, building up sophisticated databases and designing useful output to the farmers are, however, difficult problems.

Very few sheep and goat keepers do realise the economic benefits resulting from the genetic improvement of their flocks. Nevertheless, they are applying to participate in the existing animal recording schemes, aiming at getting financial subsistence coming from national or EU resources.

Under these circumstances, a large part of livestock keepers have no interest in the monthly recording results nor do they welcome the controllers in their units. It is reported that some of them force the controller to fill out the official sheets arbitrarily or complete the milking before the controller's visit because, in this way, they avoid, in their opinion, the stressing of the animals as a result of the control process.

These reactions of livestock keepers result in the controllers' disappointment, which leads them to laziness and indifference. The personnel involved in animal recording have attempted to improve this situation with personal contracts, written instructions, seminars and even threatening them with exclusion from the scheme. The general opinion is that year-by-year all the above practices have yielded positive results, e.g. the better general education of the new-comers in the recording scheme and the increase of the production yield of the recorded populations (Baltas, 1995).

Future Directions and Changes to the Design and Operation of the Scheme

According to a recent resolution of the Ministry of Agriculture, the foundation of independent co-operatives or non-profit organisations has been proposed, in an attempt to spread out the animal performance recording and apply specific genetic improvement projects more systematically. Furthermore, attempts will be made for the farmers to financially contribute to the milk recording programme, while during the previous periods the Ministry of Agriculture granted them considerable premiums to join the recording and genetic improvement scheme.

The farmers' organisations will be responsible for the identification of the new-born calves/lambs/kids, the application of milk recording and analysis of the milk samples for fat and protein content, the



Figure 5. A herd of local *Brachyceros* cattle breed in the region of East Macedonia.

collection of reproduction data and the keeping of a database for production and pedigree. For these activities, the establishment of separate organisations for cattle, sheep and goats are underway. Especially, sheep and goat breeding will be carried out in collaboration with several research institutions, which may have a breeding nucleus. Progeny testing, estimation of genetic merit and evaluation of secondary traits, will be carried out by the regional Animal Genetic Improvement Centres, in collaboration with the Agricultural Universities of the country (Baltas, 1995).

Decentralising of the production records by region (input and output) would give more flexibility to the recording programme and would allow the farmers to have the relevant records sooner.

Other planned applications are the introduction of simplified recording methods appropriate for low to medium input production systems and the introduction of computers in managing the dairy herds and flocks. Furthermore, the development of communications with the use of modems between the computing centre and the on-farm personal computers of the co-operative members will allow them to interact directly with the databases.

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Caballo Chilote

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Summary

The present paper includes an historical briefing, a morphological description of blood polymorphism, and current use of the Chilote pony horse breed. Its characteristics differentiate it from other horse breeds present in Chile.

Historical records, phenotypic and genetic characteristics show that the ancestors of this breed were brought to Chiloé by the Spanish conquerors.

The actual population of the Chilote pony in Chiloé islands, as estimated by the present study, is not more than 300 horses. In order to maintain this genetic material it appears relevant to start with a conservation project for this horse in Chile.

Resumen

El presente trabajo muestra antecedentes históricos, descripción morfológica, polimorfismos bioquímicos y uso actual del caballo Chilote, raza tipo pony. Sus características definidas lo diferencian de otras razas existentes en Chile.

Antecedentes históricos, características fenotípicas y genotípicas indican que los ancestros de esta raza fueron Caballos de la Península Ibérica traídos a Chiloé por los conquistadores españoles.

Actualmente no quedan más de 300 ejemplares en la Isla de Chiloé, por lo tanto para conservar este recurso genético aparece relevante iniciar un proyecto de conservación de la raza en Chile.

Key words: Chiloé, Origin, Blood polymorphism, Physical characteristics, Conservation, Pony.

Introducción

Ubicación geográfica

Los Caballos Chilotes forman un grupo de animales pequeños con una alzada alrededor de 120 centímetros, que se encuentran en la Isla Grande y Archipiélago de Chiloé, en el Sur de Chile (figura 1).

El clima en la Isla corresponde al templado, marítimo lluvioso. Las precipitaciones oscilan entre los 1 200 a 3 000 mm anuales. La temperatura media anual es de 10,7°C, con máximas en los meses veraniegos de 30°C y mínimas entre Otoño e Invierno de 5°C, con heladas poco frecuentes en la costa, sin nieve.

Antecedentes históricos

Los primeros caballos que llegaron a Chile, fueron los que vinieron en la expedición de Diego de Almagro en 1535, pero su número fue reducido al mínimo por las inclemencias del tiempo y en la lucha con los indios. Los que sirvieron de base de crianza a la Colonia

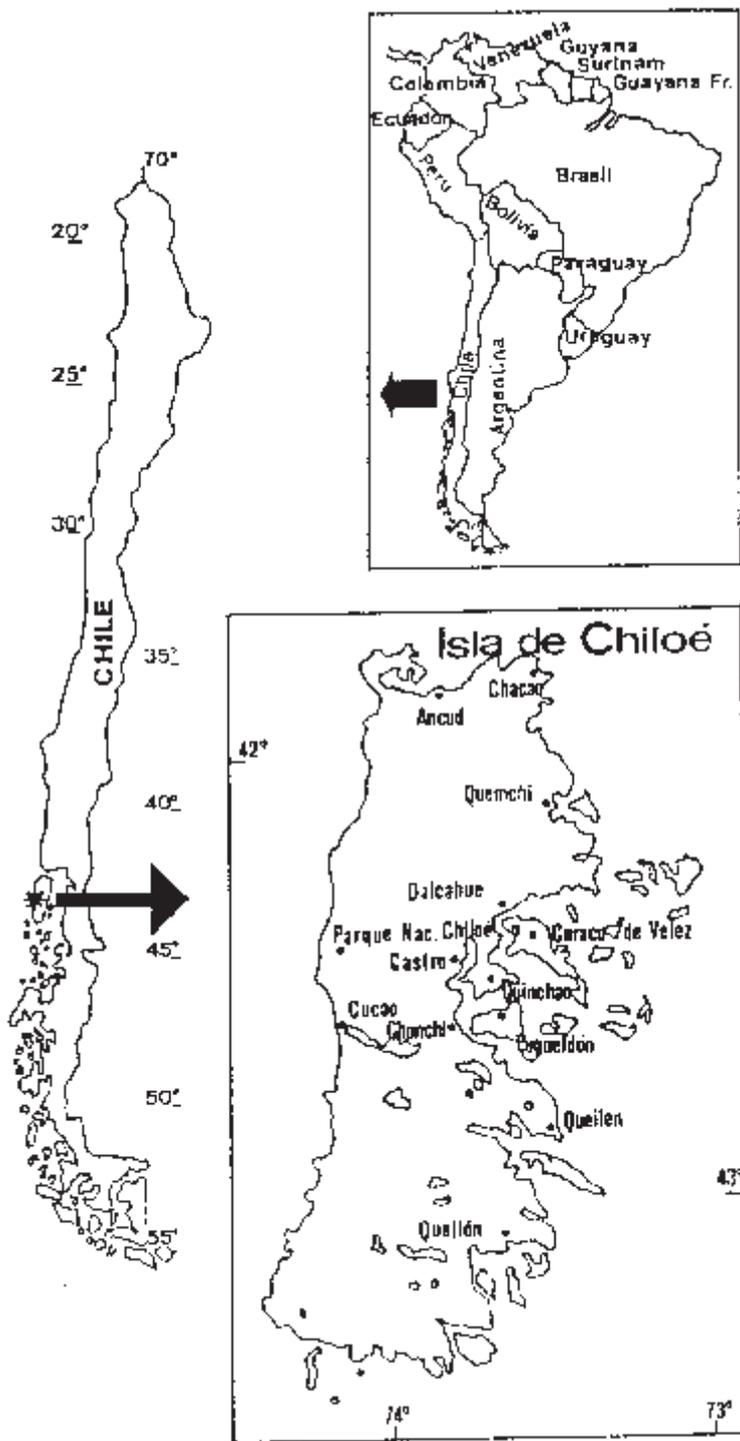


Figura 1. Ubicación de la Isla Grande de Chiloé en el Continente Sudamericano.

de Chile, fueron reclutados en Charcas (Perú) y traídos por el Conquistador don Pedro de Valdivia el año 1540 (Solonet, 1946).

Antecedentes históricos, características morfológicas y un análisis genético confirman que el Caballo Chilote tiene como ancestros caballos de la Península Ibérica. Las condiciones geográficas, climáticas y el aislamiento, formaron un tipo de caballo bien adaptado a su medio. El Caballo Chilote, en su forma actual, existe solamente en Chile y se considera como único Pony de origen Español, que se ha desarrollado en Sudamérica (Cothran y col., 1993).

Descripción Morfológica

Durante un estudio realizado en el año 1996, en la Isla de Chiloé se registraron un total de 83 Caballos Chilotes, lo cual se estima que correspondería al 30% de la población total (Voeltz, J.S. 1996).

La clasificación tipológica reveló que los Caballos Chilotes pertenecen al grupo Elipométrico según peso corporal, que su perfil generalmente es convexo o rectilíneo y que se trata de ponies con buena relación de las extremidades con respecto a la profundidad del cuerpo.

Existe una gran variedad de coloraciones del pelaje con clara tendencia hacia los colores oscuros. El Caballo Chilote es de aspecto

elegante, tiene una cabeza con líneas finas, el cuello ligeramente arqueado, magro y musculoso. La cruz perfectamente definida se prolonga suavemente hasta confundirse con el dorso.

La línea superior es fuerte con lomo y dorso corto. De grupa caída con inserción de cola baja. Los miembros son finos, bien proporcionados y en general son de posición e implantación correctas. Los cascos de los Caballos Chilotes son chicos, extremadamente duros, firmes y bien formados, aun sin manejo de despalme.

Los movimientos son armónicos, el paso es relativamente largo, el trote regular, el galope es corto y rápido, acompañado con una pisada muy segura aun en terrenos adversos. Esta seguridad en el andar es una de las características más importantes del Caballo Chilote. Además destaca por ser un animal atento y observador con un excelente carácter y una docilidad única (figura 2).

Polimorfismos Bioquímicos Sanguíneos

Se analizó un total de 58 Caballos Chilotes, tipificándose 10 polimorfismos bioquímicos, los cuales son: Transferrina (Tf), Alfa 1 Glicoproteína (A1B), Esterasas (Es), Albúmina

Tabla 1. Variables hipométricas promedios de Caballos Chilotes, obtenidos durante un estudio realizado en la Universidad Austral de Chile, 1996. (Voeltz, J.S. 1996).

Variables hipométricas promedios en cm	Caballo Chilote		
	Machos	Hembras	Media
Alzada	121	118	120
Perímetro Torácico	138	136	137
Perímetro Metacarpiano	16	15	15
Longitud Escápulo - Isquial	129	126	127



Figura 2. Estos caballos por su docilidad, son usados por niños en Chiloé.



Figura 3. El Caballo Chilote, en un paisaje típico de la Isla de Chiloé.

(A1), Proteína transportadora de vitamina D (Gc), Fosfogluconato deshidrogenasa (PGD), Fosfoglucomutasa (PGM), Glucosa fosfato isomerasa (PGI), Hemoglobina (Hb) e Inhibidor de Proteasa (PI) (Cothran y col, 1993).

A partir de las frecuencias alélicas calculadas, se determinaron diversos parámetros genéticos tales como Heterocigocis esperada, Valor de Densidad Genética, Variabilidad Genética y Coeficiente de Similitud Genética llegándose a la conclusión que indican clara y fehacientemente que los Caballos Chilotes tienen como ancestros comunes, razas de la Península Ibérica, no determinándose con precisión qué raza o razas contribuyeron al desarrollo del Caballo Chilote actual.

El caballo en la Isla de Chiloé

Como en todas partes del mundo, el caballo va perdiendo importancia como fuerza de trabajo por el desarrollo tecnológico. En Chiloé, por la situación económica de los pequeños agricultores y por las características del terreno, más la falta de buenos caminos, el caballo todavía juega un rol en la vida diaria. El caballo chico, bien adaptado al medio, con su casco extremadamente duro y su andar seguro, es el animal más adecuado para este ambiente (figura 3 y 4).

Actualmente en los pueblos aislados de la Isla, el caballo pasa a ser el medio de transporte más adecuado dado el tipo de caminos y las condiciones en que quedan éstos en la época invernal y dada la escasez de recursos tanto para el mantenimiento del buen estado de los caminos, como para la adquisición de un vehículo. El excelente carácter del Caballo chilote lo hace apto para niños, cualidad que es bien apreciada por los habitantes de la Isla de Chiloé, cuyos hijos lo utilizan como medio de transporte cotidiano.

En proporción menor se ocupa el Caballo Chilote en faenas agrícolas y para actividades recreativas, como Carreras a la Chilena. En el sector de Cucao constituyen una fuente adicional de ingresos con el arriendo a turistas, pero puesto que para arriendo el

Tabla 2. Frecuencias alélicas en los polimorfismos bioquímicos estudiados en Caballos Chilotes, 1993. (Cothran y col, 1993).

Locus	Alelo	Frecuencia Alélica	
Tf	D	0.052	
	E	0.017	
	F2	0.181	
	F3	0.086	
	H1	0.060	
	H2	0.293	
	0	0.181	
	R	0.129	
	A1B	K	0.640
		S	0.360
Es	F	0.017	
	G	0.276	
	Y	0.431	
	L	0.138	
	S	0.009	
A1	R	0.129	
	A	0.466	
Gc	B	0.534	
	F	1.000	
PDG	D	0.088	
	F	0.904	
	S	0.009	
PGM	F	0.069	
	S	0.931	
PGM	F	0.069	
	S	0.931	
GPI	Y	0.974	
	S	0.026	
Hb	B1	0.629	
	B2	0.371	
Pi	G	0.028	
	L	0.495	
	L2	0.055	
	P	0.028	
	R	0.009	
	S	0.349	
	T	0.009	
	U	0.009	
S3	0.018		



Figura 4. Son caballos de poca alzada, con buenas proporciones corporales.

visitante prefiere animales de mayor alzada, la gente en Chiloé está vendiendo sus Caballos Chilotes y los está cambiando por caballos más altos.

Métodos de Conservación de la Raza

La Universidad Austral de Chile, a través del Instituto de Zootecnia y Centro de Inseminación Artificial en conjunto con la Secretaría Regional Ministerial de Agricultura^X Región, INIA-Remehue y Carabineros de Chile, está elaborando un programa para la preservación del Caballo Chilote. Para ello se va a comenzar con un registro genealógico como base del reconocimiento oficial de la raza. Una vez aceptada, se dirigirá la crianza del Caballo Chilote en la Isla de Chiloé, para aumentar el número de animales y llegar a una población estable. Recientemente se creó un Centro de Montas en la Isla de Chiloé para facilitar la crianza de estos caballos. Además de incentivar la reproducción de los equinos en

la Isla de Chiloé, se va a promover el Caballo Chilote para el deporte ecuestre infantil a nivel nacional, se iniciará un plan piloto de Hipoterapia en la Universidad Austral de Chile, a través del Instituto de Zootecnia. Con una buena estrategia de marketing, esto puede llegar a ser la base de la preservación de la raza, ya que este caballo con su excelente carácter se presta para estos fines.

Actualmente existen algunos rebaños de Caballos Chilotes, donde se está preocupando de una crianza selectiva de animales típicos.

Además de mantener material genético en forma de animales vivos seleccionados, se está estudiando la posibilidad de conservar embriones y semen congelado.

El origen del Caballo Chilote en la Península Ibérica le puede dar cierta importancia en Europa como reserva genética, ya que los Caballos Chilotes se mantuvieron relativamente aislados y no se mezclaron con caballos de otros orígenes.

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Review of global rabbit genetic resources: special emphasis on breeding programs and practices in the lesser developed countries

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Summary

Presently, there is little organization or cooperation among countries with rabbit breeding programs with the common aim of maintaining genetic diversity, with the exception of Europe and the Mediterranean region. Particularly in the lesser developed countries (LDC's), there is limited evidence that maintaining genetic diversity in rabbit populations is even a national priority. Based on consultancies and project experiences in over fifteen LDC's, and limited reports from the literature, evaluations of breeding programs at national rabbit breeding centers have generally been less than encouraging with regard to the management of genetic resources: utilization and conservation. The purpose of this position paper is to review rabbit genetic resources management practices and trends in rabbit breeding program development which pertain to genetic resources utilization and conservation issues, and with special emphasis on the LDC's. Several measures are discussed that could enhance breeding program integrity, greater benefit limited-resource farmers, and also foster international and regional participation in rabbit genetic resources conservation programs.

Resumen

Actualmente, salvo en Europa y en la región mediterránea, existe sólo una pequeña cooperación entre países en cuestión de programas sobre razas de conejos con el objetivo común

de mantener la biodiversidad genética. En particular, en los países menos desarrollados (PMD) el mantenimiento de la diversidad genética de las poblaciones de conejos no forma parte de las prioridades nacionales. Basándonos en consultancias y proyectos realizados en más de quince PMD, así como en algunos informes presentes en la literatura, podemos decir que las evaluaciones de los programas de mejora de razas de conejos en los centros nacionales han sido, en general, poco alentadoras en lo referente a la gestión de los recursos genéticos: utilización y conservación. El objetivo de este artículo es revisar las prácticas de gestión de los recursos genéticos en conejos y las tendencias en los programas de desarrollo de mejora relacionados con la utilización de los recursos genéticos y posibilidades de conservación, todo ello con especial referencia a los PMD. Se discuten varias medidas que podrían aumentar la integridad de los programas de mejora, beneficiar ampliamente los recursos limitados de los agricultores y también favorecer la participación internacional y regional en los programas de conservación de recursos genéticos de conejos.

Key words: Rabbits, Characterization, Utilization, Conservation, Genetic improvement

Introduction

The first published report on the global need for rabbit genetic conservation programs and the organization of rabbit data banks was by Lukefahr (1988a). It is no coincidence that such program efforts, to date, have been most

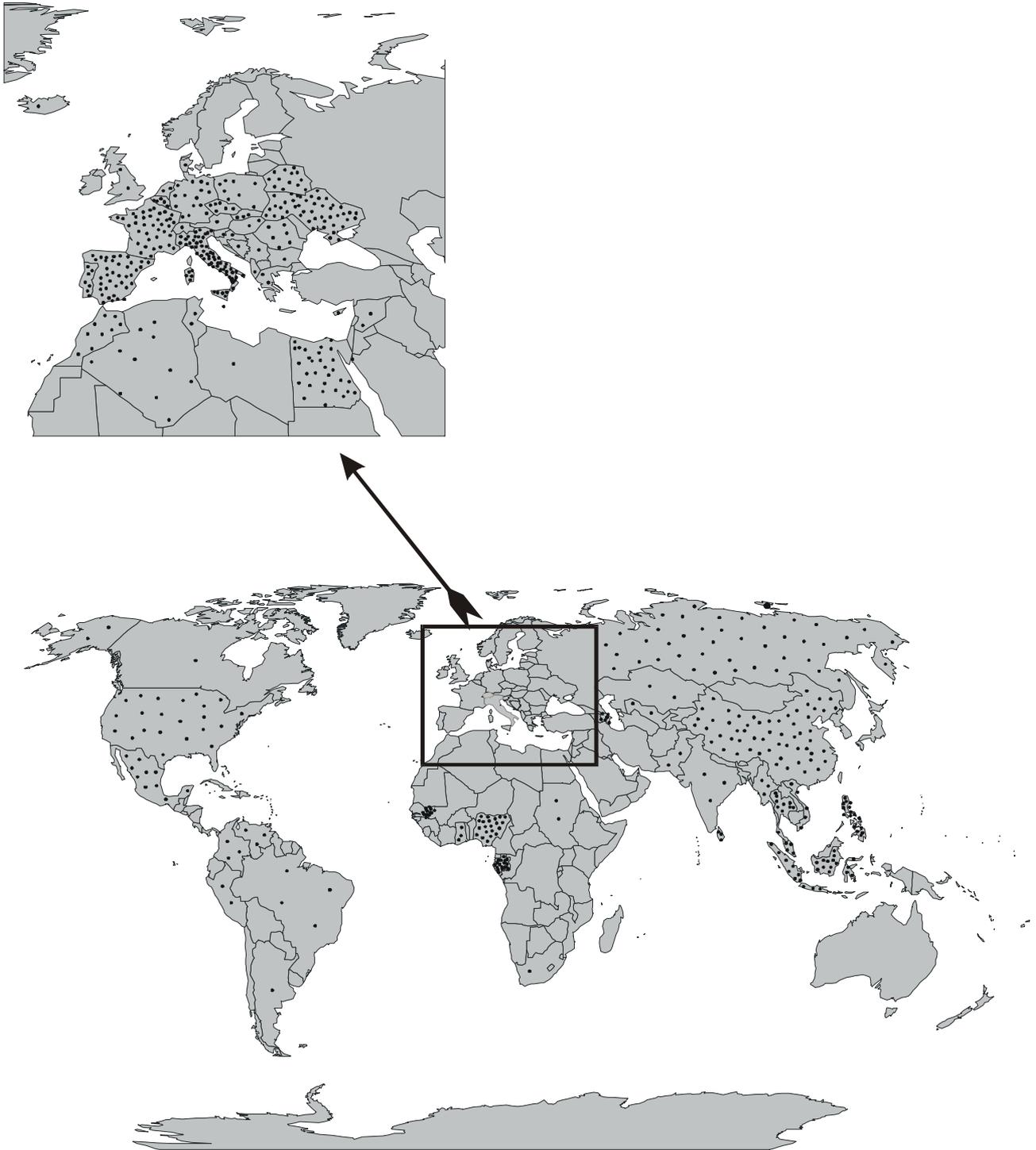


Figure 1. Female rabbit population in the World.
1 dot = 100 000 heads

active in Europe and in the Mediterranean region (Bolet *et al.*, 1996; Khalil, 1997) where the rabbit (*Oryctolagus cuniculus*) evolved and was first domesticated as a food source. According to Colin and Lebas (1995), 52% of the world's total number of breeding rabbit females (does) exist in Europe. Estimates of the world's rabbit population is 64 million does (Colin and Lebas, 1996) and 709 million total rabbits (Lukefahr, 1985). The global distribution of rabbits, based on country estimates by Colin and Lebas (1996), are presented in figure 1.

In the lesser developed countries (LDC's), the potential is greatest for inexpensively produced rabbit meat to offset national meat shortages (Owen, 1981). In recent years, small-scale rabbit projects have been gaining more international attention as a feasible measure for poverty alleviation and increasing of self-reliance in food production, two important elements in the World Food Summit Plan of Action (FAO, 1996). However, the world's distribution and level of productivity of rabbits is generally lowest in the LDC's (Lukefahr and Cheeke, 1991a) (figure 1). For instance, less than 5% of the world's supply of breeding does is estimated to be in Central and South America, only 14% in Africa, and 22% in Eastern Europe (Colin and Lebas, 1996). The same report figured that one-quarter of all breeding does exist in Asia; however, two-thirds of all rabbits in China (36% of rabbits in Asia) are reported to be of Angora breeds which are raised mainly for wool (Colin, 1995). It is evident from these figures that rabbit breeding projects in the LDC's should be expanded but also closely supported through international efforts that enhance active partnership roles such as in animal genetic resources management programs. Such international or regional efforts might be helpful in ensuring the maintenance of the genetic diversity in the rabbit for the development of sustainable production systems.

The purpose of this paper is to address several rabbit genetic resources management issues and constraints and to review trends in rabbit breeding program development with

special emphasis on the LDC's.

Recommendations will be made on realistic measures that might promote better management of rabbit genetic resources and that would also foster active regional and international partnerships in that respect.

Identification of Indigenous Breeds

Arnold (1994) reported that the rabbit was first domesticated in Europe as recent as the 18th century. Other reports indicate that domestication may have occurred as early as the 5th or 6th centuries (Sandford, 1992). One exception is the report by Chen (1984) which claims that the rabbit was first domesticated in China during the Han dynasty (206 BC to 200 AD). However, it is unclear if this involved a unique indigenous species or an introduction of European wild rabbits.

Indigenous breeds may only be found in Europe and the Mediterranean region in proximity to the rabbit's center of origin, which according to Callou *et al.* (1996) is Spain and the south of France. In this geographical context, indigenous breeds may possess the most developed adaptive qualities due to evolutionary forces. In Tunisia, local rabbits have small body size, small litters, large ears, etc.; the population has conformed to cope under adverse environmental conditions, although there is much variability within this population (Finzi *et al.*, 1988). In Egypt, Ibrahim (1988) noted that Baladi (Arabic for "local") and Giza local breeds had less dense fur than Bouscat Giant White and Flemish Giant breeds from European, and Shafie *et al.* (1970) observed that the Baladi White had lower pulse and respiratory rates and lower body temperature than the Baladi Black strain. Also, Gad *et al.* (1995) reported that NZW showed greater seasonal fluctuations in blood parameters and body weight gains than did Baladi rabbits. In Russia, the Soviet Chinchilla breed has been selected for dense fur (Miroshnichenko, 1984). Alternatively, in a socio-economic context, indigenous breeds may exist world-wide, for example, the

Criollo and Creole in Latin America and the Caribbean, the Japanese Large-eared rabbits in Asia, and "local strains" in Africa, India, Indonesia, etc.

Rabbits were probably first introduced to most LDC's less than 100 to 150 years ago. The most popular meat breeds: the Californian (CAL) and the New Zealand White (NZW), both of U.S. origin, were developed in the present century. The introduction of these two meat breeds, in particular, resulted in the displacement of indigenous or local breeds (Fauve de Bourgogne in France (Lebas *et al.*, 1997), the Carmagnola Grey in Italy (Pagano Toscano *et al.*, 1992), and the Spanish Giant in Spain (Martin-Burriel *et al.*, 1996) in many countries with a strong tradition of rabbit meat production. Later, this same trend occurred in Czechoslovakia, Hungary, Poland, and in other Eastern European countries. Such introductions continue to pose a threat to the existence of local breeds or strains.

One could divide indigenous breeds into standard and non-standard groups. Loosely defined here, a standard breed is continually selected according to a common breed description and/or performance criteria developed by a breeder's association. Generally, standard breeds are predominantly found in large commercial and/or fancy herds (*e.g.*, CAL, Dutch, Fauve de Bourgogne, NZW, and Rex), whereas non-standard breeds (*e.g.*, Baladi and Creole breeds) are more typically found in villages on small farms where they are reared under low-cost conditions (*e.g.*, fed fresh forages, seasonal breeding, and raised in hutches or underground). The rationale for this distinction is that selection criteria may well vary between these two groups. For example, a standard commercial breed may be selected largely for productivity (*e.g.*, large litters, rapid growth, and lean cutability). In contrast, a non-standard breed, may be selected largely for functionality (*e.g.*, steady reproduction [number of litters that a doe produces in a year], health history and/or rusticity). Such a major distinction should be accounted for in data bank descriptions. Of relevance, an observed trend in many countries is the

displacement of indigenous breeds or local strains as a consequence of exotic or standard breed introduction. Local populations need to be characterized and inventoried so that conservation or even preservation programs can be considered before such valuable germ plasm is lost.

Aside from Europe and the Mediterranean region, considering the brevity since domestication, to what extent do breeds and/or "local strains" (generally undefined and indiscriminantly bred stock whose relatively recent but precise origin is unknown), as presently found throughout the world, represent unique genotypes for fitness and production characters? Has there been sufficient time for natural and artificial selection to produce real diversity between country populations (between and within breeds) so as to justify conservation programs in all countries or regions? Of relevance, Martin-Burriel *et al.* (1996) observed marked genetic distances between and within several French and Spanish rabbit breeds, but similar degrees of heterozygosity, based on electrophoretic variation for eighteen blood proteins (figure 2). In the next century, molecular genetic techniques (the reader is referred to the excellent papers by Zaragoza *et al.*, 1987 and Mulsant and Rochambeau, 1996) should be especially useful in solving some of these important issues to justify the extent of global rabbit conservation program activity.

Inclusion of Fancy Breeds

In the U.S., 45 rabbit breeds are recognized, but most are solely raised for show exhibition, and therefore might be questionable for inclusion in rabbit genetic resource programs. In the U.S., there is undoubtedly better organization among clubs engaged in fancy or show rabbit breeding than there is among groups of commercial rabbit breeders, perhaps due, in part, to marginal profitability in the meat rabbit industry. Hypothetically, under the prevailing socio-economic forces, it would probably be more challenging to conserve commercial breeds that provide food and fiber than it would be to conserve fancy

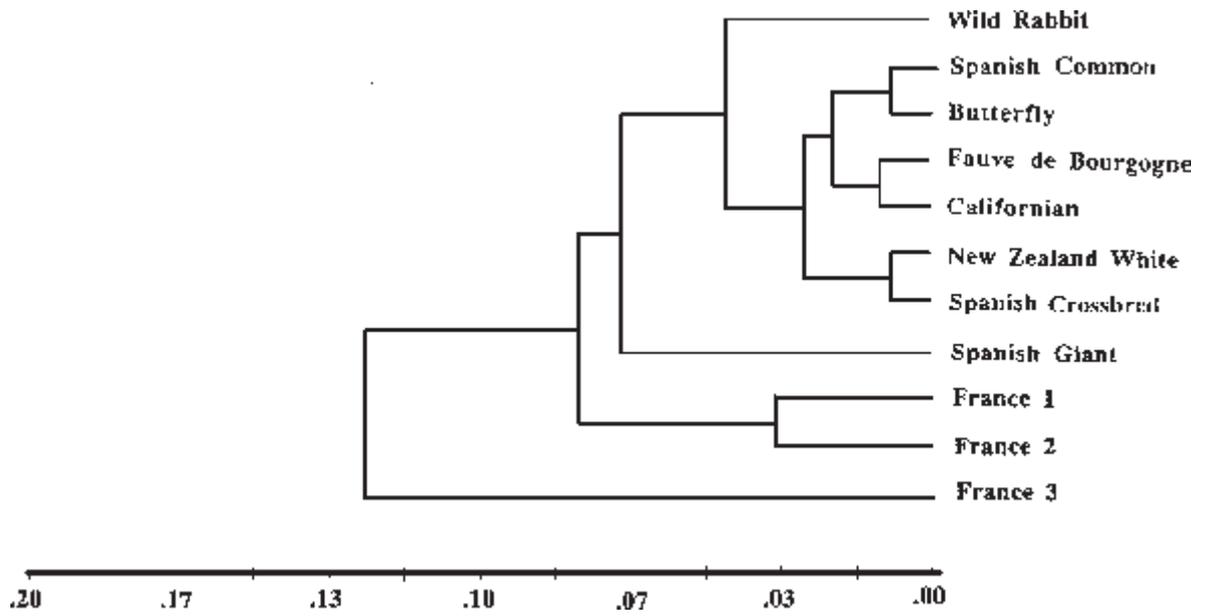


Figure 2. Genetic distance dendrogram for rabbit populations [Adapted from Martin-Burriel et al. (1996) and used with permission from F. Lebas, Editor, *World Rabbit Science*].



Figure 3. Togo. Local rabbits displaying astounding phenotypic variability indicative of high heterozygosity levels in a small rabbitry near Lome.

breeds. The same dilemma may well exist in some other developed countries. Probably the only useful information available on U.S. fancy breeds is the annual number of rabbits by breed which are registered; however, such figures are probably well below the actual (albeit unknown) population size.

All breeds - commercial and fancy alike - should at least be included in initial characterization and documentation stages of data bank processing. Some fancy breeds should probably receive higher priority for possible conservation. For example, the Flemish Giant certainly possesses genes for rapid post-weaning gains, whereas the contribution of the Netherland Dwarf breed would be seemingly negligible.

The "Purebred" Stock Myth

There is generally good agreement that many rabbit breeds exported to other countries were later outcrossed to other breeds or strains. In developed countries, for example, a common practice among fancy rabbit breeders is to outcross to other breeds to incorporate more desirable genes for specific traits. This breeding practice raises the question; "Are all purebred breeds really purebred?" Obviously not. Moreover, the term "purebred" is a misnomer. The term, "straightbred", is more appropriate. Generally, straightbred animals breed true for only a limited number of simply inherited traits, such as for coat color and for major genes which affect fur type (*e.g.*, normal, rex, and angora) and body size (*e.g.*, dwarfism). If straightbreds breed true for all traits then there would be no genetic variation and hence no opportunity for genetic progress through selection. Therefore,



Figure 4. Tunisia. Impressive ear size of a local rabbit as a vital functional trait in thermo-regulation (Courtesy of A. Finzi).

attention should not be paid as to whether a breed is truly “purebred”, but whether it is a distinct population that is utilized and worthy of conservation.

In the LDC's, where in many cases imported exotic breeds have been intercrossed with other breeds (including local strains), usage of the term “upgraded breeds” or “upgraded purebreds” is common. Should an upgraded NZW populations, for example, be inventoried as straightbred NZW? How should local strains, such as the Criollo or Kenyan White, be classified (*i.e.*, indigenous or non-native, straightbred or crossbred)? The critical decision is certainly not about which terms are most appropriate, rather it is about whether the distinct breed or strain is utilized, whereby it should be characterized, inventoried and conserved. Moreover, particularly in the LDC's, rabbit scientists should not adhere to the “purebred” myth under the popular notion, albeit false pretense, that purebreds are superior to local strains.

The Inbreeding Myth

In addition to claims of straightbred stock shortages in the LDC's, there also appears to be a common concern of deteriorative effects of inbreeding on production traits. In certain cases, especially where pedigree records have been maintained, the concern may be a genuine one because the integrity of a population could be at risk if inbreeding is not controlled. In other cases, the claim was unfounded and simply used to justify the request for a new shipment of exotic straightbreds. It has also been observed that such requests have many times involved small numbers of less than 30 breeding animals (usually because of high shipping costs or limited facilities) which would soon promote inbreeding. This pattern could yield a perpetual cycle of repeated requests for new stock. In the LDC's, a commonly observed practice among experienced farmers in rural villages is to exchange breeding bucks regularly to avoid close inbreeding.

Shortage of Straightbred Stocks

In the LDC's, a common problem claimed is the shortage of straightbred stocks. The real problem, however, is usually the lack of breeding infrastructure (*i.e.*, breed associations, breeding objectives, multiplication of improved stocks, and recording systems). However, upon close observation and inquiry at numerous national or regional breeding stations, it became evident that previously imported breeds were invariably later outcrossed to other exotic breeds or, if available, to the more plentiful local strain(s). Again, some station managers have referred to the outcross as an upgraded breed. Surprisingly, in a number of country visits, one practice is to take the offspring of outcrossed litters where there is segregation in simply-inherited genes for body coat color and group them accordingly, for example, into cage rows designated for CAL, NZW, Blue Vienna, and Chinchilla. Or, new breed names are assigned to the resultant outcross color variants (*e.g.*, “Country X” White).

Such practices would make the task seem insurmountable to ascertain real genetic diversity between breed populations among countries or regions. Molecular genetic analyses might possibly later reveal that such transitional genetic stocks are quite heterogeneous as opposed to genuine straightbred populations. If true, this could possibly be an advantageous situation because, especially in adverse environments, a high degree of heterozygosity or heterosis might be important for fitness-related characters (*e.g.*, fertility and survival) as a means of eventual local adaptation (Falconer and Mackay, 1996).

Role of Exotic Breeds

A major issue is the suitability of imported breeds (“exotics”) typically from temperate regions for ultimate use by farmers in adverse tropical or arid regions. Personal observation suggests that exotics usually have fared quite

Table 1. Exotic and crossbred mature stock inventory in 1975 at the National Rabbit Project in Ghana.*

Exotic breed	Surviving exotics		Born in Ghana			
	bucks	does	Exotic		Crossbred	
	bucks	does	bucks	does	bucks	does
Alaska	7	0	0	1	9	9
Blue Vienna	20	4	6	12	22	24
Californian	3	1	0	0	0	0
Champagne d'Argent	6	2	0	2	1	1
Chinchilla	3	1	0	0	0	0
Checkered Giant	2	1	0	0	0	0
Creme d'Argent	9	1	6	7	0	1
Flemish Giant	3	1	1	0	10	18
French Lop	2	1	0	0	2	1
Thuringer	15	4	1	11	3	3
Total	70	16	14	33	47	57

*A total of 120 animals were shipped between 1973 and 1974.

Source: Technoserve, 1975.

poorly under adverse environmental conditions at the farmer's level on small farms (Lukefahr and Cheeke, 1991b). However, in less adverse environments, such as in the Sichuan province of China, satisfactory performance of CAL and NZW rabbits in peasant villages has been reported (Pu *et al.*, 1990). More research is needed to compare breeds under local farmer conditions.

In the LDC's, there appears to be little incentive to develop new composite breeds that are better adapted under adverse environments. The author is familiar only with the reports from Brazil (Moura *et al.*, 1994) and China (Junlian and Fengyi, 1988; Zhen, 1992) on the development of new rabbit breeds which involved several generations of selection and some evidence that genetic progress was realized. It could be argued that in many LDC's there is less interest in rabbit breeding and that there is also a general shortage of animal geneticists.

Further, what evidence exists that artificial selection within present breeds or local strains has been applied and shown to be effective in

contributing to greater genetic diversity among populations throughout the LDC's? An exception may pertain to Angora rabbit breeding where artificial insemination is practised in Chile (Kappel, 1985) and in China (Yan, 1988). Another notable exception is the history of rabbit breeding in Russia (Sandford, 1992). However, if diversity is detected, the precise cause (*e.g.*, effects of selection, outcrossing or inbreeding), as well as the original genetic profile of imported exotic breeds and/or local strains involved, may not be known.

Role of Locally Adapted and/or Heterogeneous Populations

The following example is characteristic of many such experiences involving poor adaptation of exotic breeds in adverse environments in the LDC's but satisfactory performance of crossbreds in villages.



Figure 5. Dominican Republic. Appropriate use of adapted and hardy Criollo rabbits in a village development project managed by women.

Between 1972 and 1984, the National Rabbit Project (NRP) in Ghana received fifteen exotic breeds from Switzerland and the U.S. (Lukefahr *et al.*, 1992). Under local conditions of climate, fresh forage feeding with limited supplementation, and basic management, the exotics were eventually lost due to poor adaptation and/or low reproduction success (N. Mamattah, personal communication). Producing exotic x local (F_1) crosses as opposed to exotic straightbreds was generally more successful (table 1). The F_1 crosses were thrifty, had rapid growth rate, and had good fertility. In particular, when F_1 stock was later distributed to farmers for meat production in villages, breeding performance was satisfactory. Although crossbreeding was the solution in this case example, it is generally recommended that only breeds of merit (open to definition) be chosen for use in such a crossbreeding program.

In addition, a study conducted at the NRP (involving 687 rabbits and following several generations of *inter se* matings) reported a

high heritability of 0.42 for 90-day body weight, which suggested the heterogeneous nature of this composite population (Lukefahr *et al.*, 1992). In agreement, Moura *et al.* (1997) estimated heritability of 0.48 for average daily gains between 56 to 84 days of age in 1 446 rabbits from a four-breed composite population in Hawaii.

It is the opinion of the author that the maintenance of heterogeneous and/or locally adapted populations may have real merit in some situations, despite the popular notion that such stocks are genetically inferior. In particular, locally adapted populations as opposed to exotic or upgraded straightbreds may be more amenable for inclusion in genetic resources data banks and for effective conservation than attempts to reintroduce, identify or conserve exotic straightbreds or to develop new breeds at breeding stations. Local rabbits are prolific, tractable, and popular among limited-resource farmers. Another common observation is that local rabbits appear to be anatomically and

Table 2. Characteristics of anatomical and physiological soundness of local rabbits in tropical and arid regions.

Anatomical soundness

- Small to moderate mature size/large body surface area (possibly minimizes nutrition stress when the diet quality is poor/stress to high ambient temperature and/or relative humidity).
- Large ears in proportion to body size (effective means of coping with heat stress).
- Sound leg and feet structure (essential when reared on rustic hutch floors).
- Fur qualities (less dense, thin texture or diameter, and short fur to alleviate heat stress).
- Meat qualities (light to moderate rather than excessive muscling is less likely to lead to nutritional stress in fryers and in breeding stock).
- Number of functional teats (no less than 6 to 8).
- Well developed testicles and scrotum.
- Light versus dark body coat color may be advantageous.
- Absence of genetic defects (splayed legs, malocclusion, etc.).

Physiological soundness

- Adaptability to climate - Basal metabolic function (e.g., normal pulse and respiratory rates and body temperature). Normal fertility (gametogenesis) even in hot weather.
 - Adaptability to sub-optimal diets (high forage intake/appetite and good digestion efficiency).
 - Adaptability to hutch confinement (resistance to stress associated with boredom and/or inactivity).
 - Docile temperament or behavior.
 - Resistance to disease and parasites (under proper basic feeding and sanitary conditions, local rabbits are noted for their hardiness and good health).
 - Litter size/Kit survival (survival is enhanced in small to moderate size litters).
 - Body condition (vital to maintain while doe regularly produces litters [maximum of 4 litters/annum in adverse environments]).
 - Moderate milk production (risks of mastitis is presumably reduced if stock is not selected for high milking ability).
 - Slow to moderate growth rate (reduced risk of Enteritis/ Enterotoxemia is usually observed in fryers fed on high fiber/low energy diets on small farms).
-

physiologically sound in many regards as these qualities pertain to growth to mature body size, level of reproduction, and general adaptation (table 2). Qualities such as ear length, fur density, fertility during hot months, forage intake capacity, etc., may have real merit as potential selection criteria as opposed to traditional selection measures of production (e.g., litter size and growth rate). Research in this area is obviously needed.

Also, in such a population (local or heterogeneous) it would be possible to sample rabbits from villages for restocking in the catastrophic event that the nucleus stock at the breeding station was lost. Logistically, and where appropriate, this approach could enhance the security of long-term conservation efforts.

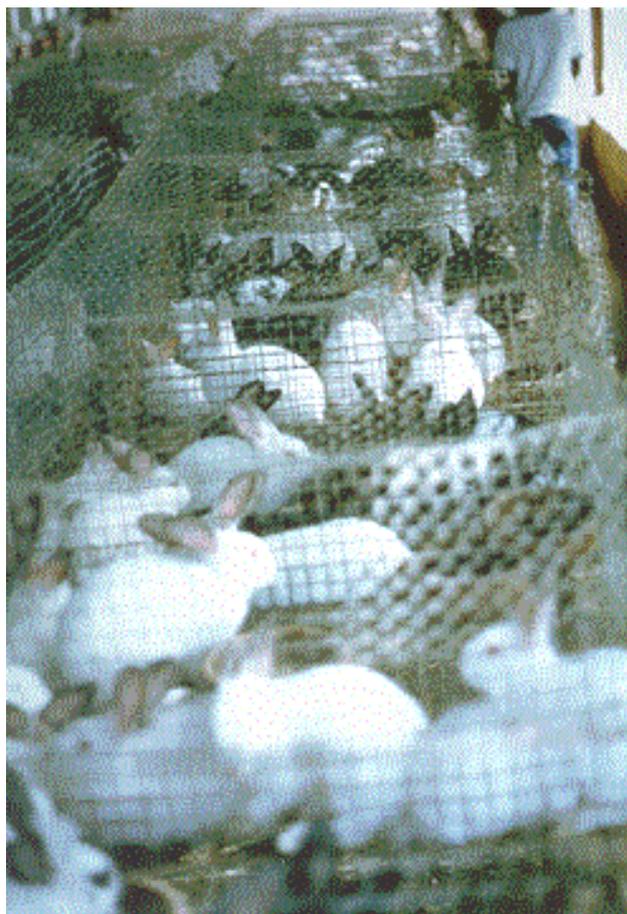


Figure 6. Dominican Republic. Predominate use of exotic breeds in a commercial rabbitry near Santo Domingo.

Facility and Resource Constraints

A major constraint in the LDC's is limited facilities, or lack of breeding infrastructure, to properly maintain closed and sufficiently large straightbred populations. In many countries there are, in fact, serious resource constraints at breeding stations which would preclude direct involvements in conservation programs. One approach would be to designate only one country in a region with the best facilities, resources, and genetic expertise to maintain valuable breeds or

strains (*e.g.*, Creole, Criollo, Japanese Large-eared, Kenyan White, and Soviet Chinchilla) as found in other contiguous countries. To reiterate, the option may exist to utilize local strains through a network of farmer leaders in a major rabbit raising region of the country, whereby this activity could lead to conservation.

In lieu of breeding stations, one option is to carry out conservation programs through the efforts of rabbit farmer leaders who represent villages in a given region. Generally, the care, feeding, and management of rabbits by experienced breeders on small farms is usually better than conditions at major breeding stations where worker incentives, feed shortages, budget constraints, *etc.*, can often be a problem. Also, exchanges of breeding stock takes place more readily amongst farmers (between and within villages or communities) than between breeding stations and farmers. Of relevance, the involvement of women project leaders is especially encouraged as there have been many such successful rabbit projects (Lukefahr, 1988b; Finzi and Amici, 1991). However, while this field-based conservation approach has its advantages, good project organization and co-ordination would be essential, and such a program would require the official approval by participating governments.

Genetic Research Priorities for Limited-Resource Rabbit Farmers

It is most unfortunate that there is a paucity of research studies that have determined the most appropriate genetic stocks for usage by limited-resource farmers. Studies from the LDC's, invariably, took place at government breeding stations or at large commercial farms where conditions are considerably different from those found in villages at the level of small-scale farmers. Further, standard breeds are typically found at the former whereas non-standard breeds (local strains) and/or crossbreds are often found in villages.

Table 3. Comparative studies involving exotic and local breeds and crosses conducted in tropical and arid regions.

Country breed*	No. of rabbits	Trait**					Reference
		LSB	SR	AWW	ADG	MW	
Benin	161						Kpodekon <i>et al.</i> and Lebas <i>et al.</i> (1996)
NZW		-	-	.37	19.4	1.49	
L		-	-	.41	23.4	1.79	
Egypt	261						Rashwan <i>et al.</i> (1997)
Baladi Red (BR)		5.6	.43	.34	14.1	1.13	
Baladi Black (BB)		6.1	.49	.54	16.4	1.45	
NZW		4.4	.77	.51	14.5	1.31	
NZW X BR		4.9	.65	.34	18.9	1.39	
NZW X BB		6.1	.65	.43	19.2	1.50	
Guadelupe							Matheron and Dolet (1986)
Creole		6.6	.68	-	-	-	
NZW		7.4	.69	-	-	-	
India	168						Sundaram and Bhattacharyya (1991)
SC		7.0	.71	.42	19.3	2.00	
L		4.6	.87	.44	12.9	1.50	
SC X L		5.2	.94	.35	16.8	1.73	
Malaysia	435						Sangare and Ariff (1995)
CAL		6.7	.46	.46	-	-	
Rex		5.6	.42	.42	-	-	
L		5.2	.52	.40	-	-	
CAL X L		6.2	.59	.48	-	-	
Rex X L		6.3	.55	.41	-	-	
Sudan	***						El Amin (1978)
Baladi		4.7	.85	.31	-	1.31	
CAL		7.1	.75	.68	-	3.79	
NZW		7.5	.74	.60	-	3.31	

* Breeds: NZW = New Zealand White; L = local breed; SC = Soviet Chinchilla; CAL = Californian.

** Traits: LSB = litter size born; SR = survival rate; AWW = average weaning weight, kg; ADG = postweaning average daily gain, g/d; MW = market weight, kg. Across studies, the AWW was recorded between 28 and 31 days (age was not specified in the Sudanese study). The MW was recorded at 84 days, 87 days, 112 days, and at maturity in the studies from Egypt, Benin, India, and Sudan, respectively. The SR measure involved preweaning survival in the reports from Guadelupe, India and Sudan, and postweaning survival in the report from Egypt.

*** Number of rabbits involved in the study was not reported.



Figure 7. Indonesia. Opportunity for on-farm research to compare breeds. Exotic and local rabbits together in a small rabbitry. (Courtesy of P.R. Cheeke).

Few reports are available involving comparisons between exotic and local breeds and their crosses, none of which took place on small farms (table 3). In contrast, there are many more reports (too numerous to include in this report) which compared only exotic breeds at breeding stations in the LDC's for potential use in commercial operations. Only one report from Egypt is presented in the table, although there have been numerous such studies reported from this country. One novel experiment by Kpodekon *et al.* (1996) and Lebas *et al.* (1996) involved the comparison of NZW to a local strain in Benin, whereby the latter genotype had significantly heavier weaning and 87-day final weights and achieved more rapid pre- and post-weaning gains. Interestingly, the study involved a French shipment of NZW neonates which were fostered to litters reared by local does in Benin. The study was conducted at a breeding station under semi-commercial conditions.

To date, results from such breed evaluation studies are inconclusive, except that breeds which bear smaller litters tend to have higher survival rates. Although the NZW was developed in the hot environment of southern California, and while in some studies (Matheron and Dolet, 1986; Kpodekon *et al.*, 1996) this breed has appeared to perform relatively well, it was not selected for adaptation to subsistence conditions on small farms. Moreover, it is difficult, perhaps even inappropriate, to make broad (across country) comparisons between local and exotic breed populations because even country populations of the same breed could be unique and also environmental and/or local conditions could vary greatly. Studies which show local breeds to be less productive than exotic (commercial) breeds does not necessarily mean that there is room for genetic improvement. Local breeds have adapted to be less productive under adverse



Figure 8. Ghana. Local doe with Flemish Giant-sired litter at the National Rabbit Project, Kwabenya. Note growth potential and large ears of kits.



Figure 9. Ghana. Poor genetic adaptation of imported New Zealand White rabbit at a remote project village site.

environmental conditions as found on small farms. The rearing of a large and rapid growing litter on a poor quality diet could be devastating to a local doe and her litter! Adoption of the use of commercial breeds may not be appropriate for reasons of economy of scale (*i.e.*, inexpensive diet of poor quality, low nutrient requirements, rustic housing, and no hired skilled labor). While commercial breeds certainly possess genes for production, they may lack essential genes for trait functionality (table 2).

A research priority is to test the relative performance of rabbit breeds and strains, exotic and local, under small farm conditions. Traits pertaining to functionality as well as productivity should be closely monitored. Better feeding and management may be essential to support exotic breeds, which in some cases may not be justified.

Of relevance, the author has assisted private voluntary organizations in arranging overseas shipments whereby exotic breeds were directly placed on selected farms in several villages where local stock were also present. This approach was preferred over sending exotics to breeding stations where conditions in some cases were known to be deplorable, and where there was little exchange between researchers and farmers. Farmers kept production sheets to collect information on breeds and crosses, although the sample size has been usually too small to draw major conclusions about the suitability of breeds or crosses. The challenge is to design or carry out projects that involve adequate numbers of small-scale farmers who keep basic production records on breeds or strains of rabbits whereby valid comparisons could be made. Such a useful study which evaluated CAL, NZW, and crossbred stock was conducted on 110 farms in Poland as reported by Brzozowski *et al.* (1998).



Figure 10. Lithuania. Traditional colony-rearing, winter hay feeding, and maintenance (non-reproduction) of tractable, mature local rabbits protected inside a farm building (Courtesy of S. Janavicius).

Conclusions and Recommendations

This paper has addressed a number of issues that relate to the identity and management of global rabbit genetic resources. The salient points of this paper are as follows:

- Indigenous rabbit breeds with major adaptation merits may only be found in Europe and the Mediterranean region from a geographic as opposed to a socio-economic context.

- Data bank descriptions should reflect the distinction between productivity of standard breeds versus functionality of non-standard breeds or strains.
- Breeds or local strains that possess truly unique genotypes of merit for fitness and production characters should receive priority as candidates for conservation.
- A country's repertoire of commercial and fancy breeds should at least be characterized and inventoried in the documentation stage of data bank processing.
- Shortages of exotic breeds in LDC's, or lack of breeding infrastructure, have often led to inbreeding or outcrossing to other breeds or strains which may complicate the task of identifying genuine breeds or unique genotypes and of detecting the precise cause of genetic diversity.
- Shipments of exotics oftentimes involve small numbers of breeding animals which can promote inbreeding.
- Facility and resource constraints and lack of breeding infrastructure at breeding stations may preclude direct involvements in rabbit breed evaluation or conservation programs.
- One country in a region with the best facilities and resources could possibly maintain valuable breeds or strains as opposed to duplicative efforts in contiguous countries.
- In the LDC's there appears to have been little incentive to develop new and more adaptable breeds, and there is limited evidence that genetic selection efforts have been effective.
- A high degree of heterozygosity might possibly enhance local adaptation for fitness-related characters under adverse environmental conditions, such as in tropical and arid regions.
- Qualities such as ear length, fur density, fertility during hot months, etc. (functional traits), may have merit as potential selection criteria, especially in regions with adverse environments.
- Heterogeneous (locally adapted) populations utilized by farmers may be more acceptable for inclusion in genetic resources data banks and for conservation

than attempts to reintroduce, identify or conserve exotic straightbreds or to develop new breeds at breeding stations.

- The suitability of exotic breeds performing under adverse environmental conditions at the limited-resource farmer level is questionable based on project cases, although literature reports are not available.
- A research priority, and an obvious challenge, is to test the relative performance of rabbit breeds and strains on small farms under limited-resource conditions.
- In conclusion, rabbits have a unique niche to inexpensively produce food and fiber for rural families, especially in the LDC's. Hence, it is imperative that global rabbit genetic resources management programs continue to focus especially on breeds or local strains that are typically utilized under small-scale and limited-resource conditions. Utilization by farmers is just as or is more important than conservation. Oftentimes, utilization is the only practical means of conservation. In some cases, conservation programs might even be appropriately and effectively conducted in the field under small-farm conditions.

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