

CONSIDERATIONS ON THE MANAGEMENT OF ANIMAL GENETIC RESOURCES IN LATIN-AMERICA¹

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SUMMARY

This paper presents an overview of population numbers, trends, contributions of animal genetic resources (AnGR) to food and agriculture production or cultural values, applications of, or lack of, breeding programmes, infrastructural issues including government and farmers' participation, special needs for conservation efforts, planned activities for implementation of conservation and utilisation of AnGR and research activities and capacity building to support strategies for conservation and utilisation of AnGR, *focusing on the strong and weak issues, politically and operatively, of AnGR as a tool for production of food and agriculture products*, which are of particular importance for the region. Moreover, the urgent need for countries in the region to develop in order to move away from poverty, unemployment and social exclusion is taken here as the underlying basis for this presentation.

KEY WORDS: breeds, crossbreeding, animal breeding, animal production.

RESUMEN

CONSIDERACIONES SOBRE EL MANEJO DE LOS RECURSOS GENÉTICOS ANIMALES EN AMÉRICA LATINA

Este trabajo presenta un panorama de números poblacionales, tendencias, contribuciones de los recursos genéticos animales (RRGGAn) a la producción agrícola y alimentaria o valores culturales, aplicaciones de, o falta de, programas de mejora genética, temas de infraestructura incluyendo participación del Gobierno y de los productores, necesidades especiales en los esfuerzos de conservación, actividades planificadas para la implementación de la conservación y utilización de RRGGAn, y actividades de investigación y construcción de capacidades para sostener dichas estrategias, *centrándose en los puntos fuertes y débiles, política y operativamente, de los RRGGAn como herramienta para la producción de productos alimenticios y agrícolas*, que son de particular importancia para la región. Además, la urgente necesidad de desarrollo de los países de la región para poder alejarse de la pobreza, el desempleo y la exclusión social es tomada aquí como la base subyacente de esta presentación.

PALABRAS CLAVE: razas, cruzamientos, mejora animal, producción animal.

LIVESTOCK POPULATIONS AND PRODUCTION STATISTICS

Livestock production is of paramount importance in Latin-America and the Caribbean, as a source of food, fibres, transport and traction, generating jobs, economic activities and trade. The numbers of animals and humans are shown in Table 1 and the food supplied in Table 2. In addition, greasy wool production in 2004 was 162,519 Mt. In 2003

the countries in the region exported USD 2,946 million in livestock products and imported USD 1,523 million (not a net regional figure, as trade among countries in the region is included).

Livestock production is a steadily increasing activity in the region as a whole, although there are important differences among individual countries. The value of livestock products grew at an average rate of 3.36% in the past 20 yr, against a human population growth rate of 1.71% (Figure 1).

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Table 1. Live animals (million head) in Latin-America and the Caribbean in 2004 (FAOSTAT, 2004).

<i>Cattle</i>	378.3
<i>Buffaloes</i>	1.2
<i>Sheep</i>	80.8
<i>Goats</i>	35.3
<i>Pigs</i>	81.8
<i>Chickens</i>	2,673.9
<i>Turkeys</i>	43.6
<i>Ducks</i>	15.9
<i>Geese</i>	0.4
<i>Other Rodents¹</i>	16.2
<i>Rabbits</i>	4.8
<i>Beehives²</i>	7.5
<i>Horses</i>	24.3
<i>Asses</i>	7.8
<i>Mules</i>	6.5
<i>Camelids</i>	6.3
<i>Humans</i>	543.2

¹Bolivia & Peru; ²Million units

Table 2. Animal food supply in Latin-America and the Caribbean in 2002 (FAOSTAT, 2004).

	Food (Mt)	Supply/Cap/Yr (kg)	Cal/Cap/Day	Prot/Cap/Day (g)
<i>Bovine Meat</i>	13,546,356	25.5	112.3	10.2
<i>Mutton & Goat Meat</i>	470,541	0.9	4.8	0.4
<i>Pigmeat</i>	5,172,041	9.8	71.2	2.8
<i>Poultry Meat</i>	12,931,715	24.4	98.3	7.8
<i>All Meat</i>	32,439,191	61.2	288.4	21.4
<i>Milk, Whole</i>	44,170,806	83.3	141.0	7.5
<i>Butter</i>	275,892	0.5	10.3	0.0
<i>Cheese</i>	1,078,125	2.0	20.7	1.4
<i>Eggs</i>	4,351,508	8.2	29.5	2.2
<i>Animal Products</i>			567.6	37.3
<i>Total Diet</i>			2,859.9	77.7

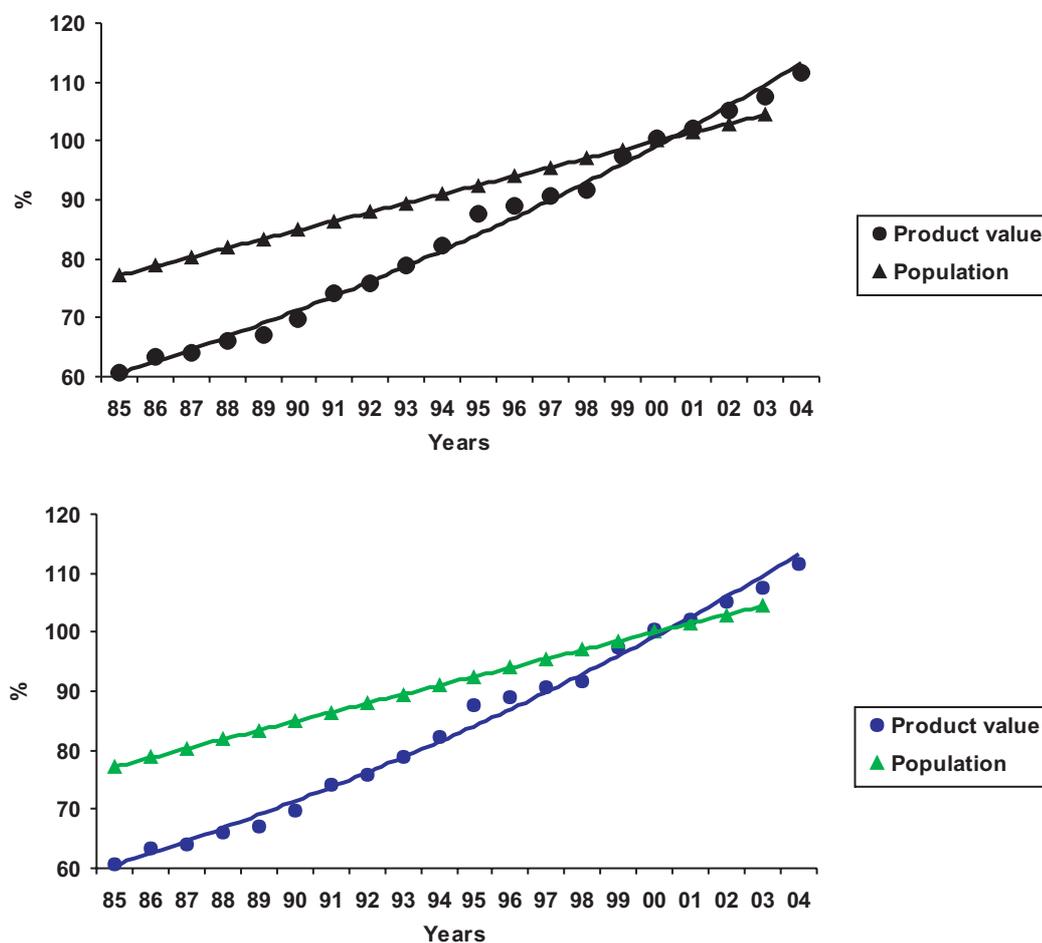


Figure 1. Livestock production value index (constant prices) and human population (99-01=100) (FAOSTAT, 2004)

ANIMAL GENETIC RESOURCES CHANGE TO MATCH THE CHANGING PRODUCTION CIRCUMSTANCES

Changes in animal genetic resources were described as follows by Madalena *et al.* (2002): "Breed substitution and development played an important role in Latin-American cattle, where different breeds replaced the naturalised Iberian types or *criollos*. In Argentina, Uruguay and Southern Brazil the local cattle were absorbed mainly by British beef breeds following access to the British market and accompanying a trend of modernisation in production systems, including fencing, started in the last quarter of the 19th century. In the temperate areas and in the tropical highlands of the Region, dairy cattle were upgraded to European breeds, the Holstein predominating nowadays, with genes flowing in mostly from North America and

Europe. In the tropical lowlands the beef cattle are now predominantly zebu, imported by private *entrepreneurs* in the early 20th century. The Brahman, originated as a composite of zebu breeds, is the most popular beef breed in Colombia, Venezuela and other countries in Central America and the Caribbean, while the Nelore, an Ongole derivative, is preferred in Brazil.

Crossing of *Bos taurus* x *B. indicus* has had a major influence in Latin-American tropical dairy cattle but not as much in beef cattle. Disorganised crossing has been practised in dairy cattle for a long time. In Brazil, some 13 million dairy cows are hybrid (predominantly Holstein/Gir crossbreds) and have been kept intermediate between both parental species for several decades, by unplanned switching of the sire species or by using hybrid bulls. Non-descript composite populations developed rather spontaneously, e.g. the "seven-colours" in Colombia and

the Carora in Venezuela (a predominantly Brown Swiss and zebu that has recently become a formal breed). Several new dairy and beef cattle breeds were developed in several countries, generally based on the “magic” 5/8 *B. taurus*: 3/8 *B. indicus* fractions, such as the Jamaican Hope (mainly Jersey:Sahiwal), the Cuban Siboney (Holstein:Brahman) and the Brazilian Girolando (Holstein:Gir). As in other regions, the combination of large-scale investment and managerial/commercial organisation required for optimal results has not yet been available in tropical dairy breed development (Madalena, 2002).

In the Southern cone of Latin-America, where most of the sheep population is concentrated, an initial period of grading up the local breed (Criolla) to Merino type breeds at the end of the 19th century was followed by a strong predominance of Lincoln and Romney crosses for export mutton meat at the beginning of the 20th century, and a subsequent period of alternated crossbreeding with Merino or Lincoln and Romney rams, depending on market trends for wool or mutton. In the 1930s and 1940s, a process of grading-up to pure breeds was initiated, the Merino, Romney, Corriedale and Polwarth being preferred in different sub-regions, which led to the disappearance of the local types and the present predominance of the wool or dual-purpose breeds. In the highlands (*altiplano*) of Bolivia and Peru, native breeds and Corriedale types predominate, mostly in smallholders' flocks, contrary to the situation in the Southern countries, so there is not the same degree of breed organisation. The same may be said of tropical wool-less sheep and tropical goats, in which organised breeding is only beginning. However, the new Brazilian tropical composite breed Santa Inés has surpassed the Southern woollen breeds in that country in registry numbers.

Because of the strong influence of breed societies, the usual pyramidal commercial structure was formed in cattle in most Latin-American countries and in sheep in the Southern ones. Selection was based on type and show ring prizes commanded fame but since the 1970s and 1980s local genetic evaluations of economic traits have been in place in several countries and steadily increased their commercial influence. Breed societies/herdbooks/show rings also existed in poultry and swine, but disappeared as these industries began using germplasm from international companies mainly after World War II. In Brazil, initially the one-day chicks were imported, but later on, large parts of the breeding programmes were locally based through joint

ventures with national companies. These private firms have their own undisclosed programmes, but in both species germplasm interchange is known to occur world-wide and local selection is important, including the assessment of molecular markers.”

Thus, improved germplasm has traditionally been –and continues to be– associated with modernization in production systems. Note that “modernization” does not mean copying Northern hemisphere systems nor does “improved germplasm” necessarily mean imported from Europe or North America, but rather an economically better performing germplasm for local production circumstances, generally developed by variable degrees of importation, crossing and local selection.³

MINORITY BREEDS AND LOCAL POPULATIONS

Besides the major genetic resources there are a variety of minority breeds and local populations constituting the genetic base of production systems less inserted into the commercial mainstream due to a variety of reasons, including the quasi subsistence nature of widespread small-holder production, local geographic and cultural particularities, such as in the Andean heights, where camelids are used for food, fibre and transport, and production of specialty products, such as tasty pork or chicken meat (some of the latter has also entered the supermarket distribution chain). Most of these populations are not well described, except for some herds kept by large farms mostly for sentimental reasons. A list of breeds and descriptors is available in the FAO DAD-IS (2005) system.

BETTER UTILIZATION OF GENETIC RESOURCES IS A CAUSE AND A CONSEQUENCE OF LIVESTOCK DEVELOPMENT

Visiting a cattle ranch, back in the mid 1950s, in a then very primitive semi-forest area on the Brazilian/Paraguayan border, I noticed that the owner, a progressive rancher, applied six technology items: 1) fencing (the 80,000 ha ranch was divided into five sub-units), 2) burning the dry grass, 3) spreading *Panicum maximum* seeds, 4) chasing wild cattle out of the forest, 5) castrating (many were adult bulls), and 6) releasing Nelore bulls. This example illustrates that genetic improvement is one of the very first techniques

³E.g., African sheep contributed to the present day's tropical breeds/populations and the African bee (*Apis mellifera scutellata*), introduced for research purposes to Brazil in 1956, got loose by accident and is nowadays widespread by natural crossing with other previously existing *Apis mellifera* sub-species of European origin, given the cross's higher vigour, productivity and aggressiveness.

adopted by farmers, provided it is really rewarding and feasible. Typical ranches nowadays are much smaller and sub-divided, keep separate animal categories, use vaccines and health practices, while the progressive ones have a range of options in improved tropical pasture species, as well as techniques for their fertilization and management, including irrigation, plus mineral/protein supplements, and send their cattle by truck to the meat packing plant. Owners, managers and workers are much more educated and have access to technical assistance and specialised information, including the web. Thus, because of the general development of the Country, partly built upon livestock development, the new production circumstances call for different germplasm. In the beef cattle case, the Nelore prevails in the tropical region, and progressive ranchers use EPD selected sires through AI. Development generated a market for improved germplasm, hence making possible to establish modern commercial selection and breed development programmes, as is also the case with dairy cattle and much more so in the poultry and swine industries.

BREEDING PROGRAMMES

Some more recent developments were described by Madalena *et al.* (2002) as follows: "Performance recording schemes in woollen sheep were started in South Africa and South America in the 1970s, run by private and/or public institutions. In the Argentine, 50 studs are currently involved (J. Mueller, personal communication) and in Uruguay, 150 (75 to 95% of the main studs in six breeds) with 20,000 wool samples being analysed annually. Wool samples are taken at shearing time, when the breeders record greasy fleece weight, body weight and a visual appraisal of the quality of the wool; scouring yield percentage, fibre diameter and staple length are assessed in the laboratory. The service provides the breeders with EPDs for all traits, plus selection indexes (Cardellino & Ponzoni, 1986). The testing costs are met by the breeders. Across-flock genetic evaluations became very important in Uruguay in the 1990s. There are at present six programmes of central progeny testing sire evaluation run by the breeders' associations and the Uruguayan Wool Secretariat (SUL). These stations also enabled comparison of the value of "genetics" imported from other countries in order to assess whether to "buy genetic merit rather than creating it" (Smith, 1989). The genetic response in greasy fleece weight varied between 0.2 and 1.4 % in different studs,

compared to a potential rate of 1.5% (maintaining fibre diameter constant).

In Brazil, performance recording programmes in beef cattle developed in the last two decades. There are currently eight multi-herd programmes recording live weights of some 250,000 young animals annually⁴. EPDs (estimated using animal model-BLUP procedures) are used by the industry. Some programmes include other traits, such as scrotal perimeter, mature weight and muscling score. Many bulls in the AI studs have EPDs, which influence the sales of semen and also the price of bulls at auctions. This was not the case a few years ago, when semen prices were only affected by the winning of show ring prizes, having no relation to genetic evaluation. These programmes are run by breed societies, group of breeders or private firms (including an AI stud) in cooperation with universities, research institutions or private firms that process the data and elaborate bull summaries. The costs are met by the breeders.

Milk recording existed for many years in several Latin-American countries, usually government subsidised, but its main function is to certify yield for commercial purposes, rather than for management, so selective recording of the best cows is practised rendering data unsuitable for genetic evaluation. A programme of progeny testing of dairy Gir sires, based on own recording, was initiated in Brazil in 1985, and up to now it has sampled 168 young bulls, 74 of which have already completed their test, with an average of 34 daughters and 92 herd-mates per sire. Both straightbred and crossbred ($\times B. taurus$) daughters are included, since crossbred performance is the main commercial objective. Temperament and milking ease are scored. Milk composition is assessed at a central laboratory. The programme is jointly run by the breed society and the Federal Research Organisation (EMBRAPA). This has been a successful partnership, as it allied the technical proficiency of the research staff with the operational ability of the private sector, thus overcoming the clumsiness inherent in public administration. A similar programme initiated in the Guzera breed in 1994, also including a linked MOET selection nucleus (Penna *et al.*, 1998). These programmes are funded by the breeders except for the salaries of the institutional staff, with occasional governmental grants."

Actually it would be more appropriated to describe those activities as genetic evaluation programmes rather than breeding programmes, as decisions on how to use EPDs is

⁴A more recent survey indicated 32 beef cattle programmes with a total of 5.01 million animals evaluated, ranging from 1,400 to 1,200,000 animals per programme (Yassu, 2004).

largely individual, except for the swine and poultry companies. Low genetic gains have been reported in dairy (e.g. Verneque, 1996) and beef cattle (e.g. Silva *et al.*, 2002, Vargas *et al.*, 2004) in spite of existing genetic variation (Lôbo *et al.*, 2000) but, to my knowledge, the selection actually practised and its efficiency have not been examined. Generation intervals in the registered Brazilian Zebu breeds are 7 to 8 yr (Faria *et al.*, 2002), certainly much longer than in optimised breeding programmes. In general, with a few exceptions, breeding for profit and the optimization of selection intensities/generation intervals have not received much attention in the scientific literature in the region, and practical breeders are generally not familiar with those concepts. There is however a growing awareness with respect to the formal definition of selection objectives (e.g. Urioste *et al.*, 1998, 2003, Vercesi Filho *et al.*, 2000, Martins *et al.*, 2003, Cardoso *et al.*, 2004).

AI and embryo transfer are readily available in many countries in the region and recently Y-enriched semen and cloning became commercially available in Brazil. Molecular genotyping is also available.

MANAGEMENT OF GENETIC RESOURCES: MUCH MORE TO IT THAN PRESERVING MINORITY BREEDS

In spite of the crucial role in livestock production played by the established breeds, these are oftentimes not considered a genetic resource. For example, in some reports the Holstein breed is not included, although it is probably the most important genetic resource for dairying in the whole region. The same applies to beef cattle and it is difficult to understand why zebu breeds are considered a genetic resource but not the Angus, Hereford or Charolais⁵. However, the FAO DAD-IS (2004) appropriately defines **“Farm animal genetic resources: those animal species that are used, or may be used, for the production of food and agriculture...”**.

Those inconsistencies may not be just mere formalities, but rather reflect different views on the relative emphasis in utilization vs. preservation of genetic resources. The following activities may be listed for action on genetic resources management (Madalena, 1992):

- description (including genomic)
- evaluation

- utilisation
- conservation.

Because the “Sustainable management of animal genetic resources” (this workshop title) is one of the most relevant activities for economic livestock systems development, it is gratifying to verify that nowadays all those four activities are considered in the definitions of management. However, if actions are to follow words, we should start by recognizing the majority breeds and populations as part of the genetic resources to be managed, and not reduce the issues involved just to the preservation of minority breeds, important as this indeed is.

Incidentally, the FAO DAD-IS (2005) definition of management includes “the accessing and sharing the benefits” of animal genetic resources, which seems to be stretching semantics rather, considering that benefits are not mentioned in the dictionary definitions of management (at least in the 23 consulted, <http://onelook.com/>). At any rate, if sharing the resources is to be mentioned, it would also seem fair to mention the sharing of patent rights originating from them.

IMPROVED STOCKS ARE BENEFICIAL, ALTHOUGH THEIR WIDESPREAD USE ENTAILS REDUCTION OF GENETIC VARIATION

As everywhere else, the intensive use of popular stocks reduces genetic variation, as some breeds decline in numbers and the dominant breeds become more inbred. As an example, it may be seen in Table 3 that the popular Brazilian breed Nelore, registering more than 100,000 animals per year had $N_e = 68$, due to linebreeding to famous ancestors facilitated by AI and embryo transfer, while the Indubrasil, a fading breed, registering only some 700 animals per year, had $N_e = 41$, as there are not so popular ancestors in this breed and AI usage is low (Faria *et al.*, 2002, Vercesi Filho *et al.*, 2002).

Because of diversity loss large scale use of improved livestock is sometimes perceived as harmful, when, in fact, it is one of the reasons for the increase observed in livestock production, which was accompanied (at least in Brazil) by a reduction in consumer prices, leading to better nutrition and health of the human population. Moreover, increased production kept inflation down, generated jobs

⁵The adjective “exotic” sometimes found in the regional literature is not very helpful (exotic: introduced from another country : not native to the place where found). Strictly speaking all but a few domestic farm animal species, such as turkeys and camelids are exotic to Latin-American, as are most of the humans.

Table 3. Census numbers, effective numbers and inbreeding in the Brazilian zebu breeds (Faria *et al.*, 2002)

	Nelore	Polled Nelore	Tabapuã	Gir	Polled Gir	Guzerá	Indubrasil	Sindi
Use ^A	B	B	B	D & B	D & B	D & B	B	D
Initial registry	1938	1969	1971	1938	1976	1938	1938	1961
Total records	4,162,149	405,383	155,494	502,995	35,247	227,721	209,224	8,778
N _m ^B	55,090	13,313	3,747	2,133	365	2,885	350	108
N _f ^B	55,801	13,140	3,808	2,234	455	2,866	384	115
N _{found} ^C	38	144	111	284	29	246	180	16
N _{ances} ^C	34	98	78	211	28	166	107	9
N _{genom} ^C	26	64	61	132	19	98	65	7
N _e ^D	68	124	54	45	24	117	41	9
F ^E %	2.13	0.98	1.58	2.28	3.06	1.75	3.44	10.13
Δ F ^E %	0.73	0.40	0.91	1.10	2.04	0.42	1.19	5.11

^A B = beef, D = dairy;

^B N_m, N_f = average number of registered males, females per annum from 1994 to 1998;

^C N_{found}, N_{ances}, N_{genom} = effective numbers of founders, ancestors and founder genomes;

^D N_e = effective population size;

^E F = average inbreeding coefficient, F Δ = rate of inbreeding per generation of animals registered from 1994 to 1998.

and foreign currency, needed for vital imports, as Brazil became one of the world's largest exporters of beef, poultry and swine meat, zeroed milk imports and has now began exporting it. The well known moral of this story is that people can't have their cake and eat it, however, when the cake is not big enough they will choose to eat (although it should not be difficult to save some of the ingredients to re-make it if necessary in the future).

IMPORTS OF STOCKS AND GENETIC MATERIALS

Importation is an important, topical issue on animal genetic resources. Because genetic improvement has an extremely favourable cost/benefit ratio when widespread over large animal populations, it is almost axiomatic that stocks improved in any country will find their way elsewhere, i.e., genetic improvement has always been globalised, and Latin-America is no exception to this rule, as is apparent from the above description.

In principle there is nothing wrong with importing any input for an economic activity, provided of course it is rewarding. However, livestock imports with public funds or subsidies have oftentimes been misused, not rare invoking benefits to the nation. "Most change has been effected by private breeders and companies. Few successful stories were reported in an extensive review of governmental programmes (Payne and Hodges, 1997). These authors indicated that with certain exceptions the importation of some 50,000 European-type cattle financed by the World Bank in several countries had not been satisfactory and substantial stock losses and poor production records were encountered. Vaccaro (1990) reported that Holstein cows in Venezuela left only 0.7 first-calving daughters in their lifetime, so they were not able to sustain their numbers. Behind such imports, generally a government subsidy scheme from the importing country operates, or a loan or gift from the exporter." (Madalena *et al.*, 2002).

On the other hand, private investors should not be prevented from introducing genetics at their own risk, provided of course that health and environmental regulations are abided by. Zebus, that now constitute the base of Brazilian cattle production, might have been banned from the Country in the 1930s, had Parliament approved a Committee's proposal, on the grounds that it would ruin the cattle industry⁶. Importing Zebus to Brazil from India and Pakistan was forbidden for many years because of alleged health safety, although "unofficial imports" are known to have occurred. The argument that "we already have all the genes we need, so we may carry out the improvement at home", may or may not be true, but investors should not be prevented from exercising their judgment at their own risk if they feel that it is more economic to import than to spend time and money selecting. Excessive trade barriers overprotecting local industries or breeders are likely to foster inefficiency (again not a privilege of third world countries). Fortunately Brazil has now taken the wise decision of lifting the ban on importing zebu embryos.

That said, it should nonetheless be clear that in many cases imports take place with no demonstration of their benefits to local farmers. The imports of Holstein semen, amounting to 1.08 million doses in 2004 in Brazil alone, are a case in point. Perhaps as a result of support prices, milk yield has won excessive importance in the selection of international Holsteins, to the detriment of fertility, health and survival, leading to a decline in those traits (Bertrand *et al.*, 1985, USDA, 2002, VanRaden *et al.*, 2005). Feeding high amounts of concentrates to dairy cows is economic only in countries that subsidise agriculture, so elsewhere, in pastures/roughages oriented production systems, milk yield has less importance compared to other traits (e.g. Vercessi Filho *et al.*, 2000, Martins *et al.*, 2003), and therefore, under those circumstances, the international Holstein may not be the best economic option in spite of its high yield potential.. Harris & Kolver (2001) reported that North American-derived Holstein cows were heavier, produced more milk volume and protein yield, had lower concentrations of fat and protein, and had poorer fertility and survival than New Zealand Holstein-Friesian cows, revealing an average advantage of \$NZ 4950 per farm per year in favour of the latter, or approximately a 12% difference in economic farm surplus. How such results would translate in Latin-America is an open question that should be addressed by research, but clearly the region cannot afford to ignore the consequences of what it does with its main dairy cattle genetic resource. In the period 1999-2004

imported Holstein semen sales in Brazil dropped at an average rate of 5.7 % per annum, while those of the local breeds Gir and Girolando increased by 19.9 and 24.0 % p.a., indicating a growing preference for less demanding animals to match the simpler, more economic production systems.

CROSSBREEDING

Crossbreeding is a major tool for economic production in most farm animal species in Latin-America., again some times perceived as detrimental because of the reduction caused in "purebred" local stock numbers. The alleged "indiscriminate crossing" may be unfair to farmers wishing to use crossbreds but not mastering the necessary techniques. I would like to exemplify with the dairy cattle situation in the tropical region of Brazil, where research results indicated very important heterosis in *B.taurus/B.indicus* crosses, so profit peaked in the F₁ and declined when moving away from the ½ gene fraction and the *inter se* cross had very poor performance, apparently due to recombination loss. The more profitable strategy was to continuously replace with F₁s, and in commercial farms, criss-crossing, the second best strategy, showed 59% of the F₁ profit, *inter se* crossing 30% and grading up to Holstein-Friesians had negative profit. (Madalena *et al.*, 1990). Those results confirmed that farmers are correct in their decades-long policy of keeping their cattle intermediate between *B.taurus* and *B.indicus*, although their methods are not well defined. In a survey of 291 dairy farms in Minas Gerais, we found that 89 % of the cows were *B.taurus/B.indicus* crosses, 46% of the farmers wished to keep their herd intermediate between both species, 12% wished to keep *B.taurus*, 2% *B.indicus* and 40% had no defined policy. About half (47%) of those wishing to keep the herd intermediate would be using just one purebred bull, implying that they would need to periodically switch the bull species to attain that objective, while 43% would use a hybrid bull and a 10% minority would practice rotational crossing. The latter figure grew to 25% on the larger farms. AI or controlled mating was practiced in 21% of the farms, and 72% had only one bull (38% in the large farms) (Madalena *et al.*, 1997). Periodically switching the species of the only bull on the farm results in too many animals of the less productive extreme *B.taurus* or *B.indicus* grades, and hybrid bulls also give poor results, so most farmers are constrained to the worst available crossbreeding strategies, although these are better than straight breeding. Under these circumstances, the production of F₁s on special farms or ranches can be a

⁶Not a privilege of third world countries: the Charolais importation to the UK in the 1960s was also discussed in the Parliament.

most convenient alternative (Madalena, 1993a,b), and is indeed an incipient but growing business in Brazil, Colombia and Venezuela, much more profitable than beef cattle ranching due to the high prices fetched by F_1 heifers (Guimarães *et al.*, 2005). More recently, a sustained decline in farm gate milk price led to widespread crossing with Gir in Holstein-Friesian herds, which may even justify the use of Y-enriched semen, provided it is of reasonable fertility (Madalena and Junqueira, 2004).

Thus, crossbreeding is a very profitable way of organising genetic resources, and instead of demeaning farmers that use it with untidy procedures it might be more rewarding to provide them with the right techniques. Through its extension service, the Department of Agriculture of the State of Minas Gerais, Brazil, promotes the use of F_1 *B. taurus* \times *B. indicus* dairy females, and official development banks have created a subsidised credit line to promote it, including development of the dairy *B. indicus* base, which is fewer in numbers than required by the increasing demand. Concerns that the parental breeds will be at risk because of crossing do not seem justified, on the contrary, dairy *B. indicus* breeds are expanding because of commercial success.

I would like to submit that the same concepts are likely to apply in many other species as well, so description, evaluation and utilization of the genetic resources, along with the study of the production systems involved, constitute highly important R&D activities for the management of genetic resources.

CONSERVATION

A variety of private and public conservation programmes are ongoing, both of live animals and genetic materials, as described in several Countries Reports available in DAD-IS (2005), along with specific conservation needs. Institutional organization for animal genetic resources varies between countries. In my opinion, Brazil was fortunate in establishing a National Genetic Resources Centre (CENARGEN, linked to EMBRAPA) and including both plant and animal resources in its mandate, since the problems involved are basically the same and a larger institution allows for a greater critical mass for technical, operational and political matters.

As suggested by Mariante *et al.*, (2003), demonstration of the potential benefits of breeds, including their use in special niches, such as organic farming or quality meat, may help preserve them. As an example, the commercial conservation of the Gir and Guzerá (Madalena, 1984) was attained in less than two decades as national and international interest in those breeds rapidly increased due

to their breeding programmes and the divulgation of research results on crossbreeding. The Caracu, a Criollo cattle breed, also ceased to be endangered in the past decade due to renewed commercial interest in it.

Admittedly, only a small fraction of breeds qualifies for commercial conservation, so special programmes are still needed for the other breeds at risk. However, some of them are rather recent unsuccessful composites and preserving them may not be warranted, including cases of breeds with ample covert crossing but retaining their original names. Also, it is questionable whether foreign breeds should be preserved in the region when they are not at risk or even counted by the millions in their continent of origin. The remaining known breeds may be dealt with following, as far as possible, theoretical principles established in the international literature on choosing breeds, representative animals, and keeping inbreeding low.

A more difficult task is to identify, localise, and describe the germplasm used by farmers off the beaten commercial track, much of which is hardly organised into breeds, either artificial or natural. Description of these stocks and of the husbandry/marketing systems, including breeding methods, selection criteria and possibly molecular genetic characterization, calls for actual field work, hardly likely to be financed as those farmers are generally in the lower income bracket.

It should be realised that in low-input systems the selection criteria of producers and superimposed natural selection may be quite different than those preferred by technical officers, so special herds of live animals might possibly be better utilised to multiply the farmers' stocks as open breeding nuclei rather than to form closed populations selected on arbitrary criteria.

CONCLUSIONS

Animal production is of paramount economic importance in Latin-America and correct utilization of animal genetic resources is an essential basis for its success. Animal breeding may be seen in a context of developing and modernizing societies in the region, particularly in the organization of animal agriculture, creating demands for improved germplasm and supplying the supporting elements to satisfy it, such as scientific, technical and general human resources and logistic background. That demand is more clearly seen in the sector of farmers inserted into modern commercial production/marketing chains, but it is also likely to exist in the low-income, non-affluent, more subsistence-oriented sector of smallholders. In the poultry and pig industries, which are better organised than the other species, international firms and national

franchisers have replaced the breed associations/show ring traditional schemes, and there are signs of a similar process initiating in beef and in dairy cattle.

Except for poultry and pigs, a general problem in breeding decisions is that too much emphasis is being placed on single traits, such as live weight in meat animals or milk yield in dairy animals, rather than on overall economic criteria. Lack of economic focus, generalised at all levels from the academia to farmers, affects all breeding aspects, including importation, upgrading, crossbreeding, new breed development and within breed selection. Private investment in local breeding programmes is slowly but steadily increasing in the region and it may be speeded up by demonstrating to the producers the economic benefits of using truly improved stock, which requires teaching them to keep and use accounting records. Also, solid research directed to provide information for sound economic decision making continues to be a major necessity.

Based on many positive examples supporting deregulation of economic activities, it is submitted that governmental organizations should interfere as little as possible in the utilization of animal genetic resources, limiting their role to regulating public health and environmental matters and developing infrastructure and human resources.

Conservation, on the other hand, clearly requires public intervention, notwithstanding existing limited private efforts, as the economic benefits may not be measured, discouraging private investment. However, because the necessary financial resources compete with so many other urgent public needs, a very limited input is expected. There is a strong case for international financing of actual conservation of genetic resources: since it is admitted that mankind should have access to and benefit from their future use, it seems justified that mankind should pay for their preservation.

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