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# Incorporation of Farmer Knowledge and Preferences in Designing Breeding Policy and Conservation Strategy for Domestic Animals

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## Abstract

It is argued that information on farmer knowledge about characteristics, adaptability and management needs of different species and breeds of domestic animals, and farmer preferences about these traits are useful inputs in designing breeding policy and conservation strategy. The argument is reinforced with several examples.

## Introduction

Thousands of genetically diverse breeds of domestic animals adapted to a wide range of environmental conditions and human needs have resulted from human and natural selection over 12000 years. Many of these breeds have also become extinct because of human activity and many more are in the process of extinction. FAO's Worldwide List for Domestic Animal Diversity lists 3882 breeds of 25 domestic species of which 75% have population data, 22% are classified as endangered or critical, and 14% are classified as at high risk of loss (Scherf,1995). About 80% of these breeds at risk occur in developing countries where few or no conservation programmes are in place.

At present, animals meet about 30%t of human requirements for food and agriculture. About 40% of the total land available in developing countries can be used only for some form of forage production and about 12% of the world's population live in areas where people depend almost entirely on products obtained from ruminant livestock. Animal genetic diversity is essential to sustain the productivity of agriculture and the livelihood of people. Ever increasing loss of animal genetic diversity erodes our capacity to maintain and enhance livestock production, productivity and sustainable agriculture. It reduces the ability to respond to changing conditions.

In this paper, we will enumerate some of the reasons for the loss of animal genetic diversity, the arguments for conservation, and the role that farmer knowledge and preferences can play in developing strategy for breeding policy and coservation.

## Reasons for loss of diversity

Genetic diversity is being lost because of human activity and changes in production systems, people's preferences and attitudes, market conditions, and opportunities. Some of the specific reasons for the loss of genetic diversity are:

a) Worldwide, the greatest threat to domestic animal diversity is considered to be the highly specialised nature of modern livestock production. In the developed countries, intensive commercial production systems are based on a few breeds that have been selected for specific traits. In the developing countries governments, and in some countries private commercial enterprises, are introducing imported exotic blood in order to meet increased demand for animal protein. Although compared to the crop sector, move toward homogenisation of the genetic base of livestock production, particularly cattle production, is fairly small in the developing countries, public policy bias toward homogenization is rather great. The short-run objective of such policy is to increase output but the long-run effect is to replace local breeds before their true potential is recognised and used as well as increase instability and costlines of the production system. For example, the success of India's Operation Flood in expanding milk production owe a great deal to the introduction of crossbred animals but because of unplanned introduction of exotic blood, the process has contributed to the neglect of the indigenous breeds (incomplete characterisation, inadequate use) leading to the reduction in the genetic base of India's dairy animals. An ironic situation has arisen where India is now importing its indigenous genetic material from other countries (Khurana, 1997). Furthermore, valuable genes from indigenous Vechur cattle and 'Booroola' gene in sheep have been patented in other countries (Devendra *et al.*, 1998). Similar examples abound throughout the developing world.

b) Ever changing production systems and production environments are also contributing to the loss of genetic diversity. Some examples are in order. (i) Increasing population pressure is a primary reason for the drastic diminution of grazing land, expansion of crop agriculture and a gradual shift from pastoralism to agropastoralism and mixed farming in Sub-saharan Africa. Such changes are often accompanied by a narrower choice of breeds and a decline in average herd size (Winrock, 1992). (ii) Clearance of forests and measures to control trypanosomosis in a vast area of humid/sub-humid west Africa, where trypanotolerant breeds used to be raised, have created favourable conditions for expansion of crop production and introduction of trypanosuceptible breeds. In the process, some trypanotolerant breeds are being replaced. It is now known that trypanotolerant breeds are also resistant to some other diseases and stresses, so a loss of these breeds will entail a loss of other important genetic traits from the gene pool (Jabbar *et al.*, 1998). (iii) The success of green revolution in Asia has resulted in the loss of genetic base and diversity of animals. In India and Pakistan, mechanisation in irrigated areas led to a shift from multipurpose (draught, meat and milk) cattle to buffalo and crossbred cow for milk production. In only few years, once dominant local exotic Red Sindhi and Shahiwal cattle breeds have nearly disappeared from Pakistan Punjab and Sind provinces. The number of Shahiwal cattle originally thought to be around 100,000, has fallen to below 6000 in 12 out of 16 districts in the Punjab. Once dominant Haryana dairy cattle breed is almost extinct from the successful irrigated areas of northwest India (Devendra *et al.*, 1998). In Nepal, farmers are moving away from local and crossbred cattle to buffalo for milk production (Tulachan and Partap, 1998). Anecdotal evidence suggest that in India, Pakistan and Nepal, buffalo is preferred because of higher fat content of its milk and higher salvage value, as buffalo meat has wider market than cattle meat. However, the importance of these and other reasons in farmer choice and selection of species and breeds for dairy production has not been established systematically to use them in designing breding and conservation policy and strategy.

c) The systems of production and management are such that in most cases unplanned indiscriminate crossbreeding and/or breed replacement is practiced, consequently some indigenous breeds are loosing their purity and special traits. Yak-cattle and Mithun-cattle crossbreeding in the Hindukus-Himalyan region and cattle crossbreeding without proper artificial insemination service in many developing countries are examples. In Bhutan, only 191 purebred Mithun exist compared with 65,000 Mithun-cattle crossbreds (Devendra *et al.*, 1998).

d) Because of natural pressure and external interventions as part of the process of development, many small ethnic communities are displaced or segregated. Such communities, because of their habitation in specific environments, may be the repositories of specific breeds of animals, which may disappear or face the danger of extinction when such ethnic communities themselves face extinction due to wars and conflicts around ethnic/national boundaries (Beilharz 1983).

e) Traditional cattle production systems involved mobility across national boundaries without significant restrictions, and adaptation to suitable locations and environments in terms of availability of feeds and avoidance of diseases. Emergence of strong national governments and greater need to protect national resources and interests have led to adoption of policies related to quarantine and disease control which may restrict cross-border movement and availability of indigenous breeds. This may eventually contribute to the loss of diversity of genetic resources.

**Need for conservation**

The need to curb the loss of genetic diversity has been well argued on biological and ecological basis. The Convention on Biological Diversity has reinforced those arguments. Conservation of animal genetic diversity is essential to global food security and meeting the challenge of the future. So far, the case for conservation of animal genetic resources has been argued on the following specific grounds:

a) Maintenance of reserve populations to overcome possible selection limits within the present breeding populations and within the prevailing environments. It is argued that response to selection will cease sooner or later, after a continuous decline in magnitude. In such a situation, reserve populations will be of value (Mason, 1974; Al Murrani, 1974).

b) Maintenance of genetic variability and flexibility to meet quickly any as yet unforeseen future requirements and challenges, e.g. new nutritional requirement for man, new kinds of feeds for animal production, new kinds of diseases and production environment (Lauvergne 1980). Utility of a species or breed to meet human and environmental needs may arise at a different time or at a different place than at present (Mason, 1974).

c) To extend man's understanding of all aspects of animal biology including a better understanding of evolution, domestication and the effects of natural and artificial selection (Bowman and Aindow 1973).

d) Maintenance of genetic variability for animal production under unfavourable conditions. Many marginal and less favourable regions are mainly suitable for livestock production. To maintain the livelihood of the population of such regions, genetic diversity need to be maintained (Rognoni 1980).

e) Maintenance of wild and domesticated breeds, varieties and herds as an expression of man's heritage and culture for educational and emotional reasons (Simon 1984).

f) It is also argued that conservation should be advocated as a general rule without detailed economic calculations and other justifications unless opponents of conservation can prove in a particular case that there is net advantage in development and human welfare at the expense of a species or breed (Tisdell, 1990).

Considering the rate at which breeds are currently being displaced or diluted by crossing, it is contended that it will not be possible to conserve all breeds, so choices have to be made and priority established (Mason, 1974; Hall, 1996). For example, Mason suggested that the following groups should be given priority: indigenous breeds uniquely adapted to their environment or showing hybrid vigour when crossed with exotic breeds, local productive breeds not known outside, genetically unique breeds, bizzare or beautiful breeds, and historically important breeds. On the other hand, Hall suggested that only most distinct breeds should be favoured for conservation.

Whichever criteria are used for making choices for conservation, genetic resources have to be properly characterised including proper valuation of the cost of lost genetic resources and the potential benefits of conservation of existing resources, particularly endangered ones. Characterisation of livestock breeds can follow three distinct pathways: phenotypic characterisation, i.e. describing the phenotype of a representative sample of the breed, usually in comparison with other breeds; genotypic characterisation, i.e. calculating heritabilities and genetic correlations of phenotypic traits thus enabling the response of the breed to selection to be predicted; and molecular taxonomic characterisation, i.e. establishing genetic distances to other breeds (Nicholas,1987; Hall and Bradley, 1995). If most distinct breeds are to be conserved, because of its objectivity molecular taxonomy may be the most appropriate technique for characterisation (Hall and Bradley, 1995). In reality, all the three pathways may be used in a complementary way.

FAO's Global Programme for the Management of Farm Animal Genetic Resources includes a number of activities directed at conservation. An important activity is the preparation of 'a global inventory of animal genetic resources, including a databank to characterise and enumerate all breeds of livestock available for use in agriculture (Hammond and Leitch, 1998). Many countries are also undertaking breed characterisation activities in relation to a single breed or a range of species and breeds. The IEMVT/CIRAD of France has a large project covering several countries in West and Central Africa involving a large number of animals (Rege and Lipner, 1992). In all these characterisation efforts, the focus is the animal and its genetic characteristics. The French study has some information on the production systems in which animals in question are raised. But the knowledge and preference of the people who own and use animals has been generally ignored.

**Role of farmer knowledge and preferences in conservation**

Only biological characterisation may not be adequate for decisions on conservation because diversity is being lost due to human activity and preferences, and human beings also adopt and adapt breeds to their needs, as explained earlier. Ultimately both the rate of interbreeding and the success of any conservation or improvement strategy depend upon the actions of the farmers who own and utilize those animals. Therefore, people's knowledge and preferences should be an integral part of characterisation. *Ex ante* assessment of farmers' breeding strategies and breed preferences can assist breed conservation and improvement efforts in several ways.

First, it can help to assess current stocks of different breeds at risk held by farmers, the geographic distribution of those stocks, and the likely future trends in those stocks. Interbreeding is more likely among animals raised in close proximity and is almost ensured when different breeds are raised in the same herd.

Second, farmer preference for different breeds, criteria used for selection of breeds, value placed on homogeneity vs diversity, the skills and information exchange mechanisms used in the process of breed selection and management, farmers' knowledge about specific attributes of different breeds under village conditions can help to focus scientific research on particular traits and identify needs for extension and farmer education. Consequently valuable time can be saved for generating appropriate breeds and production practices to meet farmer needs.

Third, information about farmers' breeding practices and breed preferences can help to identify the likely market for existing or improved breeds.

Fourth, it can help to determine the incentives that might be required by farmers for the conservation of threatened or endangered breeds (Jabbar *et al.,* 1998). The issue of private incentive for *in situ* conservation is important because genetic resources have some of the qualities of a public good: livestock breeds are widely distributed often crossing many national boundaries, and the information they contain can be made available to an individual breeder or country without diminishing its availability to someone else. Because of this nature, *in situ* conservation will require as much community and collective action as individual effort. Successful *in situ* conservation programmes have to be built on the basis of both individual and community knowledge, preferences and incentives or motivation for conservation.

Fifth, information from the market (buyers and sellers of different kinds) can complement information obtained from farmers. Market information that reveals buyer preferences for different breeds and attributes can be useful in the design of breed improvement schemes. Livestock owners who have specialized in the production and sale of animals will be particularly interested in the way buyers value different breeds in the market.

Three examples are given below to illustrate the points made above.

**Example 1 : Changing production system and breed composition in West Africa**

In the humid and sub-humid zones of west and central Africa, cattle production was constrained by the presence of tsetse fly, which cause trypanosomosis. However, over long periods of adaptation, some *Bos taurus* breeds, e.g. Muturu and N'dama, tolerant to trypanosomosis emerged. Pastoralists from the arid/semiarid zones used to migrate to the humid zone with their trypanosusecptible *Bos indicus* breeds, e.g. White Fulani, Sokoto Gudali, for dry season grazing. Contact between local and migratory herds resulted in the emergence of some new breeds, e.g. Keteku, which are also trypanotolerant. In recent times, incidence of trypanosomosis has been declining in some areas due to tsetse control programmes, deforestation and expansion of crop cultivation. Consequently, pastoralists are settling and becoming mixed farmers and raising either trypanosusceptible or trypanotolerant breeds or a mixture of both breeds. Local farmers are also adopting those breeds.

A survey among livestock owners in the derived savannah zone of west Nigeria to determine their breeding practices and breed preferences revealed that over time there was a large shift away from the indigenous *Bos indicus* breeds, Muturu and Keteku, to White Fulani but a reverse trend was found among some farmers. Farmers gave specific reasons relating to traits of the different breeds for such change. By using a matrix rating procedure, farmers' rating of different breeds with respect to milk yield, disease resistance, size of the animal, ease of handling, market value, marketability, grazing behaviour and the need for mobility for grazing were also obtained (Table 1). Using logistic regression, characteristics of farmers that would predict whether trypanotolerant breeds would or would not be raised were identified. Finally, a survey of traded cattle of different breed over a year in a major market in the study area and analysis of price data showed small but significant price differences by breed. The results indicated a possible extinction of the already small population of trypanotolerant breeds from their current habitats in western Nigeria within 20-30 years due to changing environment, production system, farmer preferences and market conditions. The results suggest that strategies need to be developed for conservation and improvement of the breeds at risk in the area (Jabbar *et al.*, 1998).

**Example 2: Farmer strategies for Yak breeding in the Hindu Kush-Himalyan region**

The breeding and rearing of yak is inextricably linked to the life and livelihood of millions of people in the Hindu Kush Himalyan region, particularly in the Tibetan Plateau, several provinces in western China, hilly areas of northern India, high mountains of Nepal and Bhutan. The various breeds of yak existing today have been the result of selection and breeding by local herders over a long time. Breeding strategies are guided by two major aims: (a) achieve productivity levels to meet subsistence needs and market demands, and (b) produce improved animals suited to specific climatic requirements of a given area as there is a lot of diversity of microclimates within the region. Throughout the region, apart from cross breeding among different breeds of yak, yaks are also crossed with cattle to produce more productive animals but this tendency has been rapidly increasing in recent times. Even with the best breeding strategy developed through generations of trial and error, the yak-cattle crossing strategy has led to a decline in the number of pure breed yaks and has created the danger of loss of the genetic base of yak population. The primary reason is that crossbreeding between male cattle and female yak produce hybrids, called *pian niu,* of which the males (called *dzo)* are generally sterile but the females (called *dzomo*) are fertile. If *dzomo* are crossbred with yak, atavism occurs after five generations. Since breeding cannot always be controlled in herds in pastoral grazing system, the result is often chaotic. Those who have more knowledge and can exercise some degree of control on breeding generally try to limit crossbreeding to two generations to maintain hybrid vigour by crossing *dzomos* with male yak. If *dzomos* are crossed with male cattle in the second generation, genetic vigour is lost (Wu, 1998). This indigenous knowledge of yak farmers gathered over centuries can be easily used in designing breeding and conservation strategies. Also incorporation of such knowledge in modern management of yak will save a lot of time as normally long periods of controlled experimentation would be required to generate the information that farmers already know.

**Example 3 : Buyer preferences for species and breeds of small ruminants in West Africa**

An analysis of 4504 traded sheep and goats of different breeds in rural markets in Southwest

Nigeria showed that buyers had systematic preferences for local West African Dwarf sheep and goat breeds and Yankasa sheep imported from northern Nigeria for specific purpose. Buyers also paid significantly different prices for different species/breeds consistent with their preferences (Jabbar, 1998).

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Table 1: Matrix rating of cattle breeds by sample cattle holders, southwest Nigeria (n=204)

| | White Fulani | Keteku | W.Fulani x N'Dama | Muturu | N'Dama |
|---|---|---|---|---|---|
| Milk yield | 9.4 (1.1) | 5.5 (1.5) | 4.7 (1.4) | 2.6 (1.1) | 3.1 (1.4) |
| Disease resistance | 2.4 (1.2) | 5.9 (1.6)[a] | 5.5 (1.4)[a] | 8.4 (1.2)[b] | 8.6 (1.3)[b] |
| Size of animal | 9.5 (1.0) | 5.9 (1.6) | 4.8 (1.3) | 2.1 (1.2) | 3.2 (1.3) |
| Ease of handling | 9.4 (1.0) | 5.9 (1.7) | 4.0 (1.3) | 2.3 (1.1) | 1.7 (1.1) |
| Market value | 9.5 (1.0) | 6.3 (1.6) | 4.4 (1.3) | 2.1 (1.1) | 2.8 (1.2) |
| Marketability | 9.2 (1.1) | 7.1 (1.7) | 4.4 (1.4) | 2.7 (1.3)[b] | 2.7 (1.4)[b] |
| Graze diverse grasses | 2.4 (1.1) | 6.0 (1.4)[c] | 5.6 (1.4)[c] | 8.8 (1.2)[b] | 9.1 (1.2)[d] |
| Need mobility | 9.6 (1.1) | 4.6 (1.5) | 3.8 (1.4) | 2.0 (1.3)[b] | 2.0 (1.3)[b] |
| **Overall rating** | 8.7 (1.6) | 5.9 (2.1) | 4.7 (1.8) | 3.1 (1.6)[e] | 2.6 (1.5)[e] |

Note: Rating out of 10. Numbers in brackets are standard deviations. Not reported are the standard errors but all of the standard errors for the attribute ratings were between 0.07 and 0.12. The standard errors for the overall ratings varied between 0.10 and 0.15.

All of the rating differences between breeds are significantly different at the 0.1% level of confidence except the following:

[a]Keteku and White Fulani x N'Dama are significantly different at the 5% level.
[b]Muturu and N'Dama are not significantly different
[c]Keteku and White Fulani x N'Dama are significantly different at the 1% level.
[d]Muturu and N'Dama are significantly different at the 5% level.
[e]Muturu and N'Dama are significantly different at the 1% level.

Source: Jabbar et al., 1998