Proc. 3rd All Africa Conf. Anim. Agric. & 11th Conf. Egyptian Soc. Anim. Prod., Alexandria, Egypt, 6-9 November 2000: 9 - 17

THE NEED TO CONSERVE FARM ANIMAL GENETIC RESOURCES IN AFRICA: SHOULD POLICY MAKERS BE CONCERNED?

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SUMMARY

The paper reviews the key factors contributing to the erosion of animal genetic resources and outlines strategic options for livestock sector policy makers to arrest it in their respective countries. In Africa, conservation of agricultural biodiversity is inbuilt into the low input – low output production strategies of the smallholder farming systems, which are often associated with poverty in rural areas. Indigenous farm animal populations are perceived to be genetically inferior, and consequently, little or no investment was provided in the past for their development under the prevailing production environments. Substitution of indigenous farm animal populations is frequently assumed as genetic improvement and is considered as the only option to increase productivity. Numerous projects have promoted and subsidized crossbreeding or modern reproductive technologies without considering the production environment. There are also no data available to assess the impact of externalities on diversity within and between livestock species. Uncontrolled crossbreeding remains a serious threat to conservation of indigenous populations. The primary policy goal for conservation of biodiversity must focus on the diversity between and within indigenous populations in farm animals. This will require close monitoring of any crossbreeding activities with exotic breeds or the importation of exotic germplasm. Genetic and phenotypic characterisation is a prerequisite whereas economic valuation of biodiversity in general or of a breed to production systems and social welfare are extremely complex to assess before perfect policy decisions can be made. However, objectives for the conservation of an indigenous farm animal population and opportunities to utilise the diversity of the indigenous livestock to meet present and future market demands, to serve as an insurance against environmental changes such as changes in production socio-economic, historic and cultural environments can be identified for research and development. To improve food security through and conservation of animal genetic resources in Africa, utilisation of indigenous farm animal genetic resources through appropriate breeding strategies such as open nucleus systems and community based management systems should be priority goals, and this cannot be realised without enabling policies. That is why the policy makers need to be concerned.

Keywords: Genetic resources, farm animals, Africa

INTRODUCTION

The international consensus to conserve biological diversity was expressed in the Convention on Biological Diversity (CBD) in 1993, and biodiversity of farm animal and plant genetic resources are the prerequisites for food security and the improvement of agricultural productivity. The CBD is a legally binding treaty and includes agricultural areas. It is not a convention to protect the environment *per se* and to maintain the *status quo* but recognizes the need for integrating conservation and the sustainable use of natural resources. The CBD provides, therefore, a framework for developing a specific sub-sector policy for farm animal genetic resources (Laing *et al.*, 1998). The CBD implies that, while nations own their biological resources, they have a duty to conserve them. Policy integration is acknowledged in the CBD and the governments need to integrate "the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies" (Article 6b, CBD). FAO (1999) is developing a global strategy for the management of farm animal genetic resources (FAnGR). The integration of such programmes into national policy-making, the creation of national or 'bioregional' ownership and the active participation of farming communities are of key importance for the success of such programmes. Major factors contributing to the loss of diversity are market and intervention failure of FAnGR in livelihood or in a market oriented agricultural systems. This calls for a new research programme looking into economic valuation of animal genetic resources (ILRI, 1999). The effect of distorting subsidies and the evaluation of externalities need to be included in a comprehensive valuation of indigenous FAnGR. National policy makers require information on direct or indirect use values of FAnGR. However, generation of

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sufficient data and testing of various methodologies will require considerable time. Phenotypic and genetic characterisation data for most of the domesticated animal species are insufficient to make perfectly informed decisions on allocation of limited funds for national conservation programmes targeting indigenous breeds across species. On the other hand actions need to be taken as a matter of urgency. Unavailability of perfect data is no justification to take a 'wait and see' position. The aim of this paper is to review key factors contributing to the erosion of animal genetic resources and to outline strategic options for livestock policy makers. This paper will focus on sustainable use policies, strategies and actions targeting farm animal populations in their natural habitat as the way forward under African conditions.

Definitions of breed, diversity and conservation

There is no objective definition of the term 'breed', which is often used in context with animal genetic resources. 'Breeds' are subjective classifications according to common utilisation pattern, habitat, degree of the openness of the gene pool or the assessment by their owners. Breed development has been closely linked to the formation of breeding societies in the early 19th century in western countries (Lloyd-Jones, 1915). FAnGR, again, is not a very clear term but probably the best to reflect the situation. In an internal proposal, ILRI defines animal genetic resources as 'those animal species and populations that are used, or may be used, for the production of food and agriculture. These populations within each species can be classified as wild and feral populations, landraces, and primary populations, standardised breeds or strains, selected lines, and any conserved genetic material'. Often, the approach on conservation of biodiversity and conservation of breeds or FAnGR are regarded as very similar activities. It should be noted that biodiversity and breed as the assumed unit to preserve diversity are conceptually quite different from each other. The stratification of species into breeds is not well established for most species. While for Africa more than 140 cattle breeds are on file (Rege, 1999) the corresponding number for pigs or pigeons is probably much less. Does this mean there is less diversity in other species than in cattle? Most likely not and we should be very careful to take the number of breeds as the only unit within species. Further, we should differentiate between genetic diversity within species and diversity between species. In the common situation of developing countries with little stratification of species into breeds a considerable larger share of the within species diversity may be allocated within rather between the existing breeds. The need for an inventory of various species and their stratification is obvious. The danger is, however, that policies may focus on an some individual breeds but forget the goal of conserving diversity and utilisation of FAnGR.

The objectives of the CBD (1992) were the "conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources..." as stipulated in article 1. This leaves ample space for interpretation and emphasis ranging from *ex-situ* preservation of individual genes to *in-situ* conservation through utilisation of entire populations.

Ex-situ conservation, the dominant strategy in plant genetic resources (PGR), is of limited practical relevance for conservation of FAnGR in Africa. Lesser (1998) states, that the complex institutional mechanism for PGR set up by FAO, the inclusion of the 'Farmer's Right' Concept and the development of a Global Plan of Action made the system less transparent for potential users and countries and prevents use of indigenous varieties. Comparing the situation in plant genetic resources, where over 1200 plant genetic resource collections worldwide contain an estimated 4.2 to 6.1 million accessions (Lesser 1998), the *ex-situ* approach for FAnGR is obviously not a relevant strategic option for Africa. Governments hold 83 %, the CGIAR system 11% and the private sector the rest (6%) of the plant genetic accessions according to Lesser (1998). The eleven gene banks of the CGIAR centres, however, keep the most unique collections with about 35% of unique samples and hold in trust more than 600 000 accessions. In Africa, a pragmatic and innovative strategy for the conservation of wildlife, which has proven to be successful, is through the sustainable use of natural resources (Krug, 1997). This method can be tried for FAGR.

The erosion of animal genetic resources and possible approaches to reduce loss of FAnGR

The key factors contributing to loss of genetic resources

Historically, extinction of breeds or strains was caused by epidemics, inter- or crossbreeding, civil conflict and migration of people. Indiscriminate interbreeding or crossbreeding and civil conflicts are the major causes for breeds or strains classified as at risk in Africa. Rege (1999), for cattle, and Epstein (1971), in earlier work for other domesticated species of Africa, provide numerous examples.

Small effective population size is a result of genetic erosion. Small populations are at risk, if no measures are taken. The estimation of the effective population size (*Ne*) offers the possibility to use one objective indicator for monitoring and planning purposes. *Ne* is calculated using the number of females and males used for breeding in a population:

$$Ne = (4Nm\,Nf) / (Nm + Nf)$$

The rate of inbreeding increases as effective population size decreases. An effective population size of less than 50 for a given strain or breed, leads to high inbreeding coefficients (F>1%) per generation and results in decreasing reproductive and productive performance. Such populations are vulnerable to sudden or persisting environmental threats. Comprehensive breeding programmes or simple action plans for the genetic improvement of indigenous populations avoiding genetic erosion are absent in most African countries (Wollny, 1995). Another fundamental cause of erosion of genetic erosion is lack of knowledge about the role of genetic variation and diversity in stabilising the prevailing livestock related farming systems. Knowledge of the existing genetic variation within and between indigenous breeds and its utilisation is simply often not available.

Cross-breeding under smallholder conditions

Crossbreeding was and still is perceived as "the way forward" to improve productivity of indigenous livestock under smallholder conditions. Often livestock policies encourage short-term solutions, e.g. promotion of 'exotic' breeds and their crosses through centralised provision of exotic x local F1 animals to farmers. This policy of 'improvement of local farm animal populations' is often simply a synonym for crossbreeding or substitution of indigenous animal genetic resources by 'exotic' animals. In many African countries bilateral or multilateral financed development projects were the driving forces to replace existing indigenous populations through 'improved' animals as discussed in Drucker (2000).

Development policies largely ignored adapted FAnGR and instead focussed on high-yielding exotics selected for high-input environments (ILRI, 1999). Consequently, the loss of competitiveness results in lower market demand for indigenous animals and their products, if no breed development according to changes of the economic and social framework conditions or the resource base takes place. It is therefore not surprising that policy makers, development project planners and even the farmers themselves perceive indigenous breeds as inferior. The switch to 'improved' breeds can become economically unviable once subsidies are not provided any more or the macroeconomic situation changes. The net benefits of crossbreeding may have been even overestimated. A comparative full cost analysis incorporating donor subsidies of crossbreeding programmes versus indigenous breed development has not been published recently. Further, there are no *ex ante* or *ex post* impact studies available, which have analysed the distorting effects of subsidies on the competitive advantage of indigenous breeds in the market place.

The value of FAnGR and conservation measures

The valuation of FAnGR is a new area and approach (ILRI, 1999). A national policy should promote and enable the valuation of the genetic resources for two main reasons: A defined value provides an incentive for preservation and, secondly, contributes to the optimum allocation of funds for promoting *in-situ* conservation. In the absence of economic estimates for indigenous breeds or unique traits, there is little evidence that governments or the international donor community would provide financial incentives to farmers. Actual programmes are based on perceived values of cultural properties or based on morale, environmental or political arguments. This is the situation we are facing in the conservation of FAnGR.

Conservation measures might be even necessary before a detailed evaluation and valuation can take place as soon as the population has reached a critical size, e.g. Ne < 50. It should be noted, however, the 'cut-off' point has to be species and population-specific and other factors must be considered before the exact risk status can be determined. The herd or flock sizes, mating structures, introduction of 'improvement programmes' through crossbreeding in an adjacent area, mortality rates, epidemic occurrence of diseases, market developments and price changes and other external factors may put a given population at risk. From the perspective of conserving inter- or intra-species diversity, interventions in favour of or against a single specific breed or strain can be wrong or counterproductive. For example, allocation of funds to provide incentives to conserve a given population under threat of extinction may contribute much less to the conservation of diversity than incentives provided to a less endangered but more distinct population. At the next layer of diversity the variation between and within species is of importance. The fact that only few breeds for some species are known compared to e.g., for cattle, cannot simple be interpreted that the species consisting of less 'breeds' is less diverse. The opposite might be the case; as such ecotypes have not yet attracted large-scale improvement programmes through crossbreeding. In summary, the research on valuation of indigenous livestock populations is still in its infancy. At present, decisions on allocation of resources for certain breeds should not be based on assumed or estimated value of certain breeds.

New data resulting from molecular genetic technology or GIS application may reveal important information about unique traits or population dynamics in future. In the almost complete absence of validated breed definitions across species and insufficiently application of standardized evaluation protocols for either genetic or phenotypic studies in Africa the decision making process on FAnGR is not practicable if it is related to individual breeds or species only. Instead, the highest priority should be given to conserve the diversity across species and breeds or strains. A pragmatic way forward could be the intensified use of the local livestock population targeting farmers in their communities as the key strategy for maintaining genetic diversity.

The need for characterisation of FAnGR

Genetic and phenotypic characterisation of locally available farm animal populations provides essential information to make rational decisions for the improvement and the development of effective breeding programmes. In an attempt to classify cattle populations of sub-Saharan Africa by various criteria and incorporating indigenous knowledge Rege (1999) and Rege and Tawah (1999) identified 47 breeds or strains out of 145, which are at risk of extinction. Recent microsatellite studies provide phylogenetic explanations to the extent that previous assumptions on centres of domestication of cattle need to be revised (Hanotte *et al.*, 2000). Their study is based on molecular genetic methodology studying the frequency of a Y specific microsatellite locus. The authors concluded that human migration, phenotypic preferences by the pastoralists, adaptation to specific habitats and to specific diseases are the main factors explaining the distribution of cattle breeds in sub-Saharan Africa. This information explains the existing diversity and provides justification to invest in the conservation of indigenous breeds from an international perspective.

Policy makers cannot wait until very specific and detailed breed or strain information is available. Phenotypic characterisation provides basic evidence for the variation between and within cattle strains, which could be utilised for selection purposes. Ruane (1999) criticises the present over-emphasis on expensive genetic distance studies, the current difficulties to validate such results, the uncertain value to provide initial information for decision-making in conservation and the imbalance between molecular studies and cheap and rapid phenotypic characterisation. In Africa, the collection of sufficient field data based on phenotypic monitoring of representative populations in the absence of a systematic recording scheme is probably more expensive than the collection of tissue samples followed by molecular analysis. These studies, however, are normally carried out at international research centres and the results are likely to be ignored by national planners. The ideal situation is to have phenotypic including biological, performance and data on costs and molecular data available.

In the short-term and under the given pressure of time to conserve and utilise the remaining indigenous breeds rapid surveys and estimation of population sizes, the distribution pattern within agro-ecological zones would provide sufficient initial information for policy makers to obtain an overview of the national livestock herd. As an immediate and simple measure livestock census data should include breed/strain information by species. A basic inventory would provide information to develop targeted breeding programmes.

Community based management of FAnGR

The literature on community based or village breeding is scanty. Soelkner *et al.* (1998) analysed determinants for success and failure of village breeding programmes citing various examples. A village-breeding programme is characterised by smallholder farming communities, often at subsistence level and a low probability of changes in the environment, i.e. major constraints of disease, feed and land shortage are prevailing. Systematic recording of performance or animal identity is usually not taking place. If any selection is taking place than the selection is often not directional, the selection goals and objectives are not defined and probably differing between farmers. The critical information is to understand the livestock owner how and why and when he or she is making decisions affecting selection of animals. The production system has be better understood in context with other farming or ex-farm activities before any successful programme could be initiated. In contrast to common reasoning that genetic improvement could not be utilised because non-genetic improvement of management factors would yield much higher result, a breeding scheme will most commonly operate in an environment, which is not changeable. In fact, most environments in African developing countries continue to deteriorate due to human population growth pressure and land degradation. Conservation policies and programmes based on the assumed condition that positive environmental changes will be successfully implemented may not be realistic. For example, El Waakel and Astake (1996) and Mwendera *et al.* (1997) describe the stressful environment for humans and their livestock in the Ethiopian highlands. Under such framework conditions the adaptive value of indigenous breeds is most likely to be rated as very high. A site-specific approach utilising the existing resources and taking into account the given constraints appears to be the only reasonable sustainable solution.

The importance of the level of human-livestock interaction is complex but often not considered in development policies and projects. Neidhardt *et al.* (1996) distinguish between livestock users, who have a purely exploitative relationship with their animals, livestock keepers, who provide some input, and livestock breeders, who have a historically well-founded relationship and implement selection and control mating. There is evidence in numerous reports (for example Rischkowsky and Steinbach, 1997; Simpson, 1999, unpublished; see Soelkner *et al.*, 1998 for various project mission reports) that 'unwillingness' to change from a livestock user to a livestock keeper or breeder is a major factor of intervention failure. This resistance to change is based on risk adverse behaviour, which is most likely the best strategy from a farmer's point of view to cope with the erratic climatic conditions or insecure market conditions. In subsistence oriented agricultural systems the transaction costs, which include cost for the exchange of agricultural products, handling and marketing costs etc., are often too high to attract farmers to sustain specialised or intensified livestock systems (Delgado, 1997). Access to education, information, health and knowledge are further constraints preventing intensified use of existing resources. It appears the sociological factor of human-livestock interaction is not fully considered in planning and implementation of livestock improvement policies. Livelihood oriented livestock farming systems are risk averse and therefore the investment is spread through keeping smaller but more and different species. Farmers are risk averse and plan for themselves but not for the national market. This is a logic decision under the given harsh conditions but counterproductive to the national goal to increase production output and efficiency. The national goal is sufficient food supply at adequate prices for the population and government may formulate policies and initiate investment resulting in higher overall production.

The increased probability for the loss of a higher producing but more disease and environmental stress susceptible animal in an unchanged production environment is often not considered in conventional improvement programmes involving crossbreeding, which assumes unrestricted feed supply and sufficient health care management. Risk aversion could be addressed through selection for adaptive fitness as an important aim in a breeding goal. The problem is that selection for low heritable and difficult to measure traits and the underlying antagonistic biological relationship between productive performance and fitness will result in low selection responses for fitness related traits. The appropriate strategy for any breeding programme would be to set suitable selection goals, which mach the production system rather than ambitious performance objectives, which cannot be reached under the prevailing environment.

The definition of a breeding goal based on a participatory process would be an essential step for a village or community based conservation programme. The policy, therefore, should promote decentralised decision-making and ensure the participation of animal owners among other stakeholders in the process of formulating a breeding goal. The starting point should be the definition of a breeding goal (Wollny, 1995). Groen (2000) provides detailed guidelines on stepwise characterisation of the animal production system and how it relates to development of breeding programmes. The paper, however, does not refer to the overall goal of conservation of animal genetic resources and assumes that choices could be made for breeds in a market oriented production system.

Open nucleus breeding could be an appropriate technological strategy for the genetic improvement in developing countries, which lack capital and infrastructure for large-scale field testing and recording. Bondoc and Smith (1993) proposed, for example, a scheme for dairy cattle in developing countries. The analysis of an open nucleus-breeding programme for sheep in Ivory Coast indicated that expected genetic progress could be realized, if management and selection pressure are maintained (Yapi-Gnaore *et al.*, 1997). Iniguez (1998) analysed breeding programmes for small ruminants in the Andean region of South America. The author concluded open nucleus programmes would fit community-breeding programmes well, if well integrated in the production process. Most breeding programmes collapsed after subsidy provision ceased. The cause, however, is most likely not the inadequate initial funding but the inadequate involvement of the community. Chagunda (2000) discusses a dispersed open nucleus scheme with animals physically not located in one place and the allowance of inflow of external germplasm into the system.

Issues of FAnGR related policies, their objectives and instruments

The FAO's (1999) global strategy on the management of animal genetic resources promotes ownership among the farming community if ever successful in Africa. However, most of the published documents (FAO, 1995&1999) put the 'breed' into focus and neglect cultural and other socio-economic factors, which form the production environment. Also research on indigenous animal breeding knowledge and practices is scarce. The market place, however, decides about the fate of a given breed. In Africa, development and implementation of national policies for the conservation of farm animal populations are competing with other burning issues and it cannot be realistically assumed that livestock oriented policies will rank very high on the priority list in future. A successful policy on conservation of FAnGR must be embedded in an overall development strategy and integrate with the policies on PGR.

Typical policy objectives and decisions to be made are on incentives to ensure low priced food products to consumers, improve food security, promote export or invest into the development of the local livestock population. An instrumental FAnGR policy may promote the active participation of the rural population in return for economic benefits within defined regions. It is the same rural population who will decide the fate of farm animal genetic resources.

We can identify four areas of policy making related to conservation of FAnGR:

- Regulation of new technologies, considering local capacity and promotion of appropriate technologies
- Monitor and control import and export of germplasm of FAnGR
- Price controls and tax incentives
- Intellectual property rights and their enforcement

a) New technologies and capacity building: In industrialised countries the development of new technologies related to animal genetics is predominantly a private sector activity, whereas most of the conventional technologies for livestock improvement are available in the public domain. The major constraint for adoption is human capacity to assess and to implement appropriate technologies. Consequently, the technology transfer potential between developed and developing countries cannot be fully utilised by the national agricultural systems (NARS). The non-profit organisations of the Consultative Group International Agricultural Research (CGIAR) centers should be encouraged to have closer collaboration with development-oriented programmes to enable a faster technology transfer in Africa. Emphasis should be given to scientifically sound methodologies on how to evaluate indigenous knowledge in animal breeding and how this could be incorporated into innovative breeding programmes. It is obvious that government policy should enable and promote the capacity for training and research in the area of animal breeding and molecular genetics at higher and intermediate level. Also impact assessment requires an interdisciplinary approach and regional co-operation and networking are essential.

b) Migration of germplasm: Historical analysis and most recent data provide sufficient evidence that indiscriminate use of exotic germplasm has dramatic effects on genetic erosion (Iniguez, 1998; Hanotte *et al.*, 2000). In most countries the import of exotic germplasm and the conduction of crossbreeding programmes is poorly controlled. Crossbreeding or development of synthetic breeds may have advantages in certain areas such as peri-urban dairy production. However, the genetic impact on genetic diversity must be monitored and controlled. A clear policy on crossbreeding, which takes the need for conservation of FAnGR into account, is required. It should be discussed, under the premises of conservation of genetic resources and fair and liberalised market development to remove any direct or indirect incentives for the introduction of exotic breeds.

c) Price controls and tax incentives: In the spirit of the CBD the recognition is adopted that users and beneficiaries should pay the full value for the resources they use. This would include externalities. In the absence of a valuation of FAnGR, their contribution to biodiversity and the non-existence of an international market for the use of indigenous genetic resources the total economic value of FAnGR is not known. From a pragmatic point of view the provision of direct and indirect incentives to utilise indigenous animals could possibly lead to a self-sustaining conservation programme. The promotion of marketing facilities, establishment of revolving funds for open nucleus systems or adequate grading systems would be enabling policies. Providing access to pastures for pastoralists, where appropriate, promotion of livestock clubs and recording systems, the promotion of formulation of adequate breeding objectives, the development and co-ordination of decentralised breeding programmes should be further key elements of a national livestock policy plan. Support to develop local products, value-added products or specific labels could be further strategic option to convert a market failure into a market success for local breeds. The most effective option, however, is probably to remove restrictions affecting local breeds and their products and to remove incentives promoting use and import of exotic genotypes.

d) Property rights: The discussion on intellectual property rights (IPR) of plant genetic resources is well advanced (see Lesser, 1998) in contrast to the discussion on property rights of FAnGR. The failure of existing property rights systems in plant genetic resources to provide protection and benefits to local and indigenous communities are one of the more contentious issues of the CBD. IPR and patenting will become an issue but patents are not granted for an entire plant or animal organism and the costs are prohibitive. IPR protection is applicable to animal genetic material with unique characteristics or for characteristics, which can be induced through technological procedures, as specified by national and international patent regulations. A financial system would be then required to assist local and indigenous communities and procedures and regulations for the actual transfer of genetic material needs to be worked out. However, there is little hope of getting such a system functioning and for plant genetic material a *sui generis* system is proposed (Lesser, 1998), which conceptually separates ownership of genetic material from ownership of knowledge. It can be argued, that a policy claiming property rights - in whatever form - for FAnGR material appears to be of little benefit at present. The bulk of the genetic material is of no known use or function and has no present market value. Restrictive national policies on international research of animal genetic resources and their exchange are short sighted. Recently, policy statements providing a framework for the use of genetic resources, intellectual property rights and biotechnology were issued by the CGIAR centres (CGIAR, 1999). The value of such a statement is to ensure that important genes or gene combinations are maintained in the public domain. In contrast, claiming unspecific property rights for the protection of indigenous genetic resources, which cannot be enforced, would appear to be useless and counterproductive to development. The potential value of a gene is correlated to the knowledge and not the gene *per se*. Material transfer agreements, as practised for plant genetic resources could be drafted, if there is any doubt by the provider on the future use of the sample taken. At present most African countries have no infrastructure to implement legislation on IPR for FAnGR. On the other hand the common heritage approach is coming to an end and policy makers must be sensitised on the optional value of the indigenous FAnGR. A precautionary measure, e.g. applying a safe minimum standard, of maintaining the FAnGR as any other natural resource would enable policy makers to develop adequate access legislation and genetic material transfer agreement as a response to new discoveries in biotechnology in future.

CONCLUSION

At present indigenous FAnGR of Africa are perceived as inferior and no economic values have been defined. This perception is in sharp contrast to reality. The significant dependency of the majority of the human population on indigenous livestock populations and their interaction is a fact for Africa. Research methodologies on valuation of FAnGR, indigenous knowledge and how farmers and other stakeholders could participate in this process are in development.

Further advances of biotechnology will possibly result in commercialisation of genes or combination of genes and a value could be acquired. The discussion on intellectual property rights will become more relevant as soon as biotechnology derived identifiable products from indigenous farm animal genetic resources become available. Lessons learnt from policies on plant genetic resources may help in the formulation of policies but need to be specified for animal genetic resources,-which are more complex. At present genes determining unique traits or optional values are non tradeable and should remain in the public domain controlled by independent organisations. Any restrictions will negatively affect scientific progress. This development needs to be closely monitored by national policy makers in future.

The efficient utilisation of indigenous farm animals by maintaining genetic variation and minimizing counterproductive effects of livestock production on the natural environment appears to be the most pragmatic and sustainable strategy option. Removal of counterproductive incentives and control of crossbreeding are strategic options of high priority.

Diversity of FAnGR is not static but dynamic. The challenge is to avoid further erosion of adapted or unique populations and the replacement by genotypes, which are not competitive under the given or future environmental conditions. Improvement of food production derived from animals is simply not possible without conservation of FAnGR and their important characteristics and traits. And this is why policy makers need to be concerned and need to formulate enabling policies.

ACKNOWLEDGMENTS

The author is indebted to his colleagues at the International Livestock Research Institute (ILRI) especially Dr Ed Rege, Dr Enyew Negussie and Dr Mohamed Salem among several others, who provided valuable comments. I have to thank the German Ministry of Economic Co-operation (BMZ) and the Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) for providing the opportunity to visit ILRI where most of the work for this paper was done.

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