Animal Biodiversity Basis for Sustainable Agriculture

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Agricultural Biodiversity includes all components of biological diversity of relevance to food and agriculture: the variety and variability of plants, animals and micro-organisms at the genetic, species and ecosystemic level, which are necessary to sustain key functions in the agro-system, its structures and processes.
Agricultural Biodiversity is essential to the world for the following functions:

- sustainable production of food and other agricultural products, including providing the building blocks for the evolution or deliberate breeding of useful new varieties;
- biological support to production via, for example, soil biota, pollinators and predators;
- wider ecological services provided by agro-systems, such as landscape protection, soil protection, water and air quality.

Agricultural Biodiversity includes the following: higher animals (domestic and wild animals, wild and farmed fish); higher plants (crops, wild plants, trees, pasture species); insects (including pollinators or involved in soil cycle); other macro-organisms (e.g. earth worms): micro-organisms (e.g. rhizobia, fungi, disease producing pathogens).

There are several distinctive features of agricultural biodiversity compared with other components of biodiversity:

- agricultural biodiversity is actively managed by farmers;
- many components of agricultural biodiversity would not survive without this human interference; indigenous knowledge and culture are integral parts of agricultural biodiversity management;
- in regard to crop and livestock diversity, diversity within species is at least as important as diversity between species;
- because of the degree of human management, conservation of agricultural biodiversity in production systems is inherently linked to sustainable use;
- nonetheless, in industrial-type agricultural systems, much crop diversity is now held ex situ in gene banks or breeders' materials rather than on-farm.

Conservation of Animal Genetic Resources

Animal genetic resources are the building blocks for livestock development. Genetic diversity enables farmers and breeders to utilize a wide range of production environments and develop diverse products to meet the needs of local communities. The diversity also allows farmers and breeders to respond to changing environmental conditions and consumer demands.

The contribution of animal genetic diversity in agriculture, economic development and resources management is a major consideration for its conservation. At the same time, being an integral component in many social and cultural traditions, diversity

contributes to individual and community identity.

A conservation strategy is more than just a technical program. It must contain an awareness building component and a planning process that promote wide involvement and commitment of all stakeholders. Within countries, the building of partnerships among government agencies, local authorities, farmers, researchers, business interests and nongovernmental organizations is critical to a successful conservation strategy. Farmers, who own and utilize livestock, must be involved in the process as their decisions influence the direction of animal production and the future of a given local breed. Ensuring profitability of production is the most important goal for farmers; therefore, conservation activities must consider the need of farmers to generate income.

Conservation Methods

Conservation efforts can be broadly categorized as *in situ* and *ex situ*. *In situ* conservation means that animals are kept in their production system, in the area where the breed developed its characteristics. *Ex situ* conservation applies to situations where animals are kept outside their area of origin (herds kept in experimental farms, farm parks, within protected areas or in zoos) or more often, when genetic material is conserved and stored in gene banks.

Both conservation approaches have advantages and disadvantages. Until recently, there was a lot of enthusiasm regarding the potential of *ex situ* conservation as the most reliable and cost-effective conservation strategy. This view was further reinforced by the development of biotechnology.

However, in situ conservation, particularly in cases where specific breeds are endangered, is now recognized as a more effective, primary approach and efforts in this regard are increasing.

In situ Conservation

In situ conservation facilitates breed characterization, evolution and adaptation. Under *in situ* conditions, breeds continue to develop and adapt to changing environmental pressures enabling research to determine their genetic uniqueness.

The most cost-effective approach to in situ conservation is to maintain locally adapted breeds within commercial or subsistence production systems. Specific traits, often expressed in indigenous breeds, including hardiness, fitness, longevity, low feed requirements, resistance to diseases and relatively high reproduction performance can be extremely beneficial. Moreover, lower yields from locally adapted breeds can be compensated by higher lifetime production, as well as from their lower total maintenance costs.

Locally adapted breeds can also be used in crossbreeding programs especially when their prolificacy and maternal abilities are high. The ability of locally adapted breeds to perform in low-input stressful production systems provides the basis for sustainable agriculture. This is true especially in many regions of the world where there is routine exposure to environmental stressors such as disease and extreme climatic variation.

The following objectives may underpin an in situ conservation program:

- To conserve the processes of evolution and adaptation of animal populations to their environments.
- To conserve diversity at all levels - ecosystem, species and within species (breeds and genes).
- To integrate farmers (mixed farmers, pastoralists) into a national AnGR system.
- To conserve ecosystem services which are critical to the functioning of the earth's life-support system (i.e., maintaining soil-forming processes, reducing chemical pollution, restricting spread of animal and plant diseases, etc).
- To improve the livelihood of resource-poor farmers through economic and

social development (i.e., combining in-situ conservation with development of local infrastructure, or increasing access by farmers to locally-relevant animal and plant (forage) germ plasm).

• To develop systems to make conserved material (i.e., semen for local use) or conditions easily accessible to farmers.

Advantages and Disadvantages of In Situ Conservation of AnGR

One major advantage of AnGR is that it conserves both the genetic material and the processes that give rise to the diversity. Thus, adapted indigenous breeds can be co-conserved with wild species, maximizing system output sustainability. Long-term sustainability of breeding efforts may depend on the continued availability of the genetic variation that can be maintained and further developed by the herders themselves using their own management practices. Moreover, because the technology for cryopreservation of AnGR is only well-developed for a handful of livestock species, conservation of most livestock species will continue to depend on live animals. In almost all cases, interventions supporting continued evolution (in response to changes in the production system) are cheaper and more effective for AnGR in situ conservation.

Unfortunately, in situ conservation also has some drawbacks.

The first one is that the same factors that allow for dynamic, holistic, agro-ecosystem conservation, may serve to threaten the security of breeds/strains. For example, genetic erosion can still occur due to unforeseen circumstances such as war and natural disasters. Moreover, social and economic change may either foster or hinder in situ AnGR conservation over time. Indeed, one of the challenges of in situ conservation research is to evaluate how economic development is affecting farmer maintenance of diversity so as to account for this process in the implementation of conservation programs.

Ex situ Conservation

Ex situ methods are generally regarded as an accompanying measure to *in situ* conservation. Cryoconservation provides a long-term insurance to conserve genetic diversity for future needs and demands for animal products. However, cryoconservation neither permits characterization of breeds nor provides a full range of socio-economic, ecological or cultural benefits that can be achieved through in situ methods. Moreover, as the genetic make up of a breed is frozen, it cannot adapt to changing environmental conditions.

Another disadvantage of cryoconservation is that breed restoration may be extremely costly and time consuming. But as a complementary conservation approach, cryoconservation provides a long-term insurance system to *in situ* conservation.

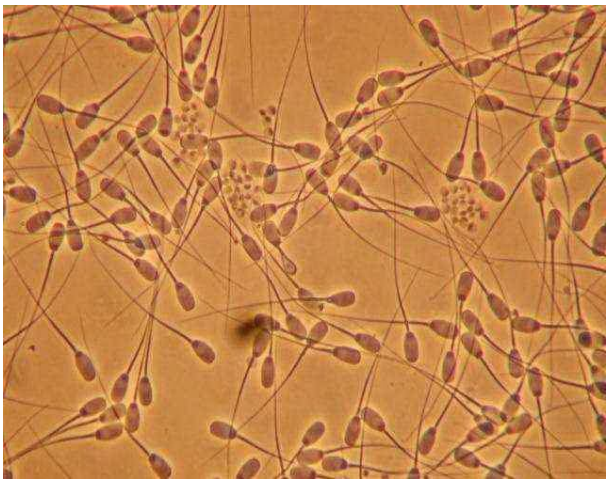
Cryoconservation requires modern facilities and skilled personnel and is expensive. In the majority of *ex situ* banks, semen and embryos are the most common genetic material.

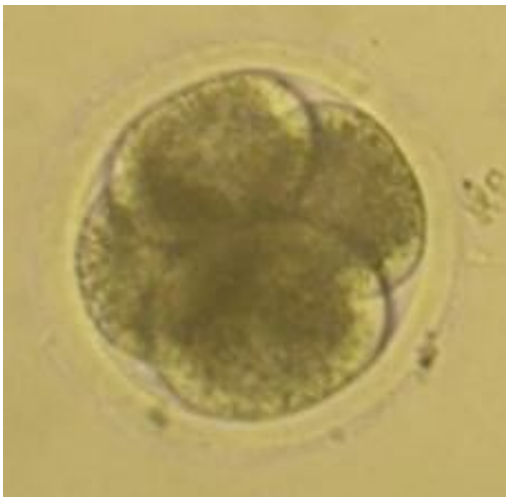
There are also programs that include the storage of oocytes, tissue and DNA. *Ex situ* establishment is most advanced for cattle and small ruminants, although other farm animal species, especially pigs, horses, rabbits, poultry and fish, are being stored through cryoconservation.

Another major advantage of *ex situ* conservation is that combining the biotechnologies of reproduction (e.g. in vitro fertilization, cloning, embryo transfer,

poliovulation, etc.) the results could be more spectacular than using natural reproduction.

A key element of the operation of *ex situ* conservation banks is the establishment of protocols for the collection of genetic material, health and quarantine requirements, evaluation of biological value of stored material, access to stored resources and replenishment procedures.





Preserving Genetic Resources.

In order to survive, humankind needs to ensure that the genes of crops, livestock, other food species, and the agricultural biodiversity, of which they are a part, should be continuously under development in farmers' fields. Backup storage (frozen in time in international gene and semen banks and free of the threat of patenting), can store a limited slice of the diversity but this must be kept in the public domain so that it is accessible to all farmers and growers. However, vigilance is required to safeguard these resources from contamination by GMOs, especially in the centers of origin and diversity of the world's crops and livestock.

The following provide opportunities and incentives for a more secure food future:

• farmers' actions on conserving and using diversity;

• publicly-funded gene banks;

• the FAO International Treaty on Plant Genetic Resources for Food and Agriculture;

• consumer choice for diversity in their food and farm production.

With farmers' actions and Civil Society and official support, through a virtuous circle of consumers supporting farmers to produce the diversity of foods, nutrients, textures and tastes that consumers want and need, agricultural biodiversity will thrive.

Farmers' actions on animals' diversity

Generally, animal keepers can follow two alternative strategies: *adapt the environment to the need of the animals or keep animals adapted to the respective environment*. The first strategy is used in industrial animal production such as chicken batteries or large-scale pig fattening. Here, animals are divided into production animals and breeding stock. To take advantage of the economy of scale, production animals need to be uniform. For the specialized breeding stock, some diversity is desirable as breeding progress depends on selection, but industrialized animal production and efforts to maintain or enhance biodiversity remain antagonists.

Smallholders and pastoralists follow the *"keep animals adapted to the environment"* approach. Environment in this sense is not restricted to natural conditions, but also includes the production systems. The physical environment greatly differs between locations, just as production systems differ according to available resources and economic conditions.

Because of this, smallholders and pastoralists need different animal species and diverse types.

The common indicator for farm animal diversity is the number of breeds. However, smallholders and pastoralists do not need breeds but animals with certain characteristics.

In "modern" animal production, livestock is kept for meat, milk, eggs, wool or hides. Smallholders and pastoralists also significance differs from "modern" animal production with respect to forage management. In modern systems, the requirements of animals are calculated, rations are formulated, and, if necessary, feed can be bought and imported. In contrast to that, smallholders and pastoralists have to optimize the use of the existing, limited forage. The different approaches also favor different genotypes.

The ways animals are kept also influence the desired types. On extensive pastures in dry lands, animals should be able to walk long distances.

When they are herded, it is advantageous if they have a drive to stay together. When goats are kept in enclosures, it is of advantage if they are short legged and cannot jump the fence.

Traditional Practices on Animal Genetic Resources Management

Within smallholder and pastoral systems, purposes or functions of animals strongly influence the type of animals and animal species used.

Practically all domestic animals can be used for meat though culture and religion can limit its use. The types of animals used depend strongly on economics, especially on price ratios of live weight to feed. As meat is comparatively cheap in most smallholder and pastoral areas, animals there have to do with natural forages and crop residues, and the uses of these forages for meat production have to be optimized. The types of animals required are those which grow reasonably well under these conditions.

Most local livestock breeds in rural environments are products of a community of breeders. This community of breeders lives in the same area, keeps and breeds animals for a specific purpose and exchanges animals mostly among themselves. The manner by which people utilize and breed their livestock is determined by their cultural norms.

Some Traditional Practices are influenced by the following criteria:

- if livestock is considered communal or private property
- ritual and social aspects
- keeping a mix of breeds
- resistance to diseases
- resistance to environmental conditions
- the pleasure of the owner.

For milk production, cattle, goats, buffaloes and camels are commonly used. The type of animals depends strongly on the access to markets. In mountainous areas, it makes little sense to keep high-producing dairy cows if roads are blocked by snow in winter and if the present dairy production is sufficient for household use. If the available forage on a farm is not sufficient for a cow, switching to smaller species, such as dairy goats, can be a viable option.

Low maintenance requirements are an advantage. Draft animals and beasts of burden

are often used only for parts of the year. For the rest of the year, animals have to survive in reasonable conditions, without too much cost.

Cattle, buffaloes, donkeys, horses and camels are the most important species, but there are other species, including sheep, goats and even dogs which locally carry loads.

Hutul horse breed used in mountain regions.

Crossbred animals might be bigger and stronger, but often additional draft power is not needed and therefore, the indigenous animals are usually preferred.

In the absence of banking services, animals are efficient "saving accounts". Often several species are combined: e.g., chicken as small change, sheep and goats for recurrent expenditures, such as school uniforms, and cattle for bigger expenditures. Animals kept as saving accounts require minimal care and therefore should not require expensive feed, should be docile and resistant to diseases. These characteristics are in favor of indigenous breeds.

Animals kept because of their cultural importance differ according to area and culture. We have to accept that in many areas, horses are regarded as more valuable than donkeys, even though donkeys require minimal care and are extremely useful.

Animals may also be kept for other functions, e.g. as "watch dogs" (not only dogs, but also donkeys which can protect small ruminants against predators, or geese which are good "alarms").

Animals are usually kept for several purposes and therefore the type of animals actually kept is often a compromise. The importance of different functions varies over time. The conservation of farm animal genetic resources in smallholder and pastoral systems must, therefore, be dynamic and adaptive and not static.

Traditional practices for breeding and selection of animals can be summarized in the following methods:

- pedigree keeping
- selection criteria
- offspring testing
- avoiding the inbreeding
- castration of not desired animals.

Linking Community Traditional Practices with Academic Institutions

As it was shown, the traditional practices have many different criteria, but they have not a scientific method and that is why it is necessary a linkage between them.

From the start of the collaborative activities, both parties must be engaged as a team in the different aspects of intervention in the community and to have a project with the following purposes.

Capacity-building

This project could be named Community Biodiversity Development and Conservation (CBDC) Project and must induce collaboration between the Local Administration, Academy and Universities.

Through this collaboration, contributes to improving the technical capacities of the CBDC staff and in the same time, to reveal to local administration and to Academic institutions witch are the real needs to preserve AnGR.

It enhances the technical dimensions of its community-based work and conversely, the collaboration enables the Academic institutions to engage and acquire capacities in community-based participatory research and extension.

Capacity-building came in the form of formal training activities organized by both or either parties, as well as through mechanisms of meetings, informal discussions, planning and co-implementation of activities. Ultimately, the collaboration helped in the capacity-building of farmers through the participatory on-farm research and trainings conducted.

In the participatory research and extension, certain steps are undertaken:

1. Formation of a core group
2. Site selection and conduct of participatory rural appraisal
3. Setting-up of on farm research and introduction of new materials into the community to increase local genetic diversity and help farmers evaluate and identify locally-adapted materials.
4. Conduct of community training (e.g., farmers' field schools) and development of evaluation mechanisms and documentation of trials.
5. Advancing selected materials.
6. Setting-up of local genes bank

Alongside on-farm trials managed by farmers, the research team facilitates training and technical discussions with farmers to enhance their knowledge and skills in various aspects of AnGR conservation and development.

The Farmer Field School has three main learning components: special topics (for conceptual learning); field exercises (for skills practice); and field studies (the set of trials managed by farmers). The research team continues to provide technical assistance to

farmers, to further enhance their farming systems.

The research collaboration aims to create principles and methods in community-based participatory research and extension, and principles and methods in community genetic resources conservation and development and in the end, the cooperation between Local Administration and Academic Institutions will give the logistic and scientific support to create a Local Bank for Genetic Material.

The final result of this Project must be to develop a zonal sistem in which the farmers, scientists and politiciens work together for the community benefit based on a sustainable agriculture and protection of ecosystems for the future generations.

Sustaining the Future of Food Supplies

Animal genetic diversity will ensure the variety of traditional products witch are natural and tasteful and are appreciated by a large number of consumers.

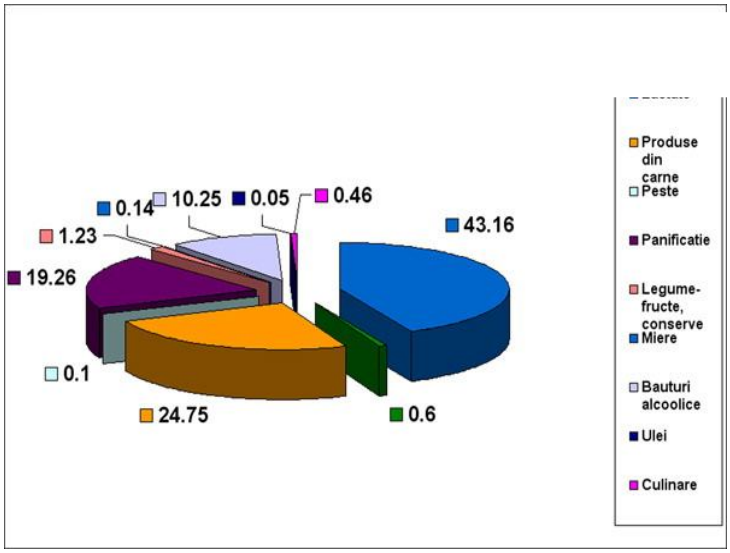
Production and successful marketing of goods and services that are highly valued by consumers can promote maintenance of minor breeds. This provides an economic incentive for farmers to conserve and use a breed that may otherwise be lost. This incentive-based approach has been successful in many regions of the world.

Market identification is a type of incentive approach that has also proved successful in many countries where local or regional products and traditional processing are highly valued by consumers.

Situation of traditional products on categories and zones

Zone	Meat products	Milk products
ALBA[1]	72	164
ARGES[2]	58	419
GALATI[3]	32	47
TIMIS[4]	66	25
BIHOR[5]	77	100
BRASOV[6]	59	85
IASI[7]	172	93
TOTAL	536	933

Share of traditional products nationally certified, by product



Source: National Office of Romanian Traditional and Organic Products

[1] Counties: MURES, SIBIU, ALBA, CLUJ
[2] Counties: ARGES, DOLJ, ILFOV, TELEORMAN, GIURGIU, OLT, VALCEA
[3] Counties: BUZAU, GALATI, CALARASI, BRAILA, IALOMITA, TULCEA, VRANCEA, CONSTANTA
[4] Counties: CARAS SEVERIN, GORJ, MEHEDINTI, HUNEDOARA, ARAD, TIMIS
[5] Counties: SALAJ, MARAMURES, BISTRITA NASAUD, BIHOR, SATU MARE
[6] Counties: COVASNA, BRASOV, PRAHOVA, DAMBOVITA, HARGHITA
[7] Counties: SUCEAVA, BOTOSANI, NEAMT, IASI, BACAU, VASLUI

Milk and meat traditional products

Financial support granted by the National Rural Development Programme

Measure 123 - Adding value to agricultural and forestry products

Within the measure, the prioritary units of the primary production sectors are: (i**) milk and dairy products; meat, meat products** and eggs, (ii) cereals and bakery products, (iii) vegetable, fruits and potatoes, (iv) obtaining and using bio-fuels, (v) oilseeds, (vi) honey, (vii) wine.

Measure *211 - Financial support for less-favoured mountain areas*

Measure *214 – Payment for agro-enviroment*

Financial support granted by the state budget.

Legislation for financial support from the state budget for measures of protection of Animal Genetic Resources:

O.U.G.nr.194/2005 for measures of protection and preservation of AnGR from species and breeds in danger of extinction

Leg.nr.137/2006 for the approval of O.U.G.194/2005

Ord.555/2006 for the approval of eligibility criteria and financing methods for preservation programs.

Agroturism

In Europe, increased interest in agro-tourism provides opportunities to conserve locally adapted breeds and increase economic diversification.

The succes of agro-turistic activity is influenced by some factors such as natural landscape, ecosystem, plants and animals, traditions, culture, local arhitecture. This is an opportunity for people who live in towns to come closer to nature, to get to know and appreciate rural life and agricultural activities, to learn about plants and animals and the way food goods are produced.

This will stimulate the farmers to protect old and endangered breeds not only for the pleasure of visitors, but to produce and sell natural traditional products, make money and develop their farms.

Conclusions

The first step to conservation and sustainable use of animal genetic resources is understanding its critical roles and values. Such understanding has to be developed through continuous communication with stakeholders and society, through educational programs, and widespread dissemination of information and knowledge about animal genetic resources. When it has been determined that a breed conservation initiative is required, it must be strategically planned considering local capacities and conditions, market opportunities and potential for collaboration among stakeholders.

Such an action must be strongly supported by governmental and academic institutions, as well as local community factors. Only a large scale cooperation for this purpose will ensure success in the preservation of AnGR and thus, the future of nature and humankind.

References:

1. Ayalew Kebede, W. 2000. Do Smallholder Farmers Benefit More From Crossbred (Somal x Anglo-Nubian) than from Indigenous Goats? Goettingen, Univ. Diss., 155 pp.
2. A.T. Bogdan, St. Mantea, Dorina Bogdan Tratat de reproducţie şi însămânţări artificiale la suine. Ed. Tehnica Agricolă; Bucureşti; 1999.
3. FAO. 1998. Proceedings of the 6th World Congress on the Genetics Applied to Livestock Production, FAO/6th WCGALP Workshop on Animal Genetic Resources and Sustainable Development, Armidale, NSW, Australia, January 1998, Volume 28.
4. FAO. 1999. Sustaining Agricultural Biodiversity and Agro-Ecosystem Functions: Opportunities, Incentives and Approaches for the Conservation and Sustainable Use of Agricultural Biodiversity in Agro-Ecosystems andProduction Systems.

5. FAO. 2000. World Watch List for Domestic Animal Diversity. Third Edition. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 726 p.
6. Gandini, G. and J. K. Oldenbroek. 1999. Choosing the Conservation Strategy: Genebanks and the Conservation of Farm Animal Genetic Resources, Edited by J.K. Oldenbroek ID-DLO, The Netherlands.
7. Groombridge, B. (ed.). 1992. Global Biodiversity: Status of the Earth's Living Resources. Compiled by WorldConservation Monitoring Centre.Chapman and Hall,London.
8. ITDG, ETC Group and GRAIN. 2002. SustainingAgricultural Biodiversity and the Integrity and Free Flow ofGenetic Resources for Food and Agriculture.
9. Johnson, H.D. (ed). 1987. Bioclimatology and Adaptation ofLivestock. Elsevier World Animal Science. Amsterdam. 279 pp.
10. Ştefan Mantea. Biotehnici şi biotehnologii de reproducţie la porcine. Ed. Bioterra; Bucureşti ; 2000
11. Moyo, S., J.E.O. Rege and F.J.C. Swanepoel. 1994. Evaluation of Indigenous, Exotic and Crossbred Cattle forBeef Production in a Semi-arid Environment. Proc. 5th World Congress Genet. Appl. Livest. Prod. 20: 344-347.
12. Mulvany, P. 1996. Dynamic Diversity. Paper presented duringthe 5th Global Biodiversity Forum, Buenos Aires.
13. Sahai R. and R.K. Vijh (eds). 2000. Domestic AnimalDiversity Conservation and Sustainable Development, SIPublications, Karnal (Haryana) 132001, India.
14. Mariana Sandu, A.T. Bogdan: Identificarea unor nuclee din rasele rustice de porcine Bazna şi Mangaliţa în vederea conservării biodiversităţii animale; Simpozionul C.S.C.B.A. " Ziua internaţională a biodiversităţii" , 22 mai 2008, Academia Română.
15. Mariana Sandu, Şt. Mantea: Bitehnologia însămânţărilor artificiale la suine; Simpozion CSCBA "Dezvoltarea şi conservarea biodiversităţii zootehnice prin biotehnologii de reproducţie";2 septembrie 2008, Academia Română.
16. Mariana Sandu, Ştefan Mantea, Pavel Nefir, Alexandru T. Bogdan : Biodiversitatea populaţiilor indigene de ovine şi caprine în judeţul Caraş-Severin
17. Scherf, B. (ed) 2000. World Watchlist for Domestic AnimalDiversity, 3rd edition, FAO, Rome, Italy.