Gene Banks for Animal Genetic Resources: the FAO Perspective

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The importance of animal genetic resources and their conservation

The perspective of FAO regarding animal genetic resources for food and agriculture (AnGR) and their conservation, including through gene banks, is largely indicated in the *Global Plan of Action for Animal Genetic Resources and Interlaken Declaration* (FAO, 2007). The *Global Plan of Action* is the first internationally agreed framework to halt the erosion of livestock diversity and support the sustainable use, development and conservation of animal genetic resources and the *Interlaken Declaration* is the introductory text through which countries affirms countries' commitment to its implementation. In the *Interlaken Declaration*, FAO Member Countries recognized that "the genetic resources of animal species most critical to food security, sustainable livelihoods and human well-being are the result of both natural selection, and directed selection by smallholders, farmers, pastoralists and breeders, throughout the world, over generations. The result is a wide variety of livestock breeds that provide a diverse stream of benefits to the environment, humanity and its cultural heritage". They further note that "erosion and loss of animal genetic resources for food and agriculture would compromise efforts to achieve food security, improve human nutritional status and enhance rural development". Therefore, they "recognize that prompt action should be taken to conserve animal breeds at risk".

The member countries confirm their "common and individual responsibilities in respect of conservation, ... of animal genetic resources" and "commit (themselves) to achieving" this objective. Although they "recognize that the main responsibility for implementing the *Global Plan of Action*" "rests with national governments" they "acknowledge that major gaps and weaknesses exist in national and international capacities to ... conserve animal genetic resources" and "recognize the need to promote technical and financial cooperation at the regional and international levels among countries. Finally, they "acknowledge the essential role of the (FAO) in supporting country-driven efforts in implementing the *Global Plan of Action*".

The importance of conservation of AnGR is indicated by the contents of the *Global Plan of Action*. The Global Plan of Action has four Strategic Priority Areas, the third of which is dedicated to conservation of AnGR. The Strategic Priority Areas have 23 Strategic Priorities. Conservation hasfive Strategic Priorities (SP) 1) to establish national conservation policies (SP7), 2 and 3) to establish or strengthen *in situ* (SP8) and *ex situ* (SP9) conservation programmes, 4) to develop and implement regional and global long-term conservation strategies (SP10) and 5) to develop approaches and technical standards for conservation (SP11). In accordance with the *Interlaken Declaration*, FAO is supporting countries in their efforts to implement these SP and the *Global Plan of Action* in general.

National conservation policies

FAO encourages member countries to update existing or develop new National Strategies and Action Plans (NSAP) for management of AnGR in light of the approval of the *Global Plan of Action.* Technical guidelines for preparation of NSAP were developed (FAO, 2009). These guidelines recommend the establishment of national goals for conservation of AnGR, along with their sustainable use and development and to use these goals as the basis for drafting the NSAP. No particular emphasis was noted for conservation versus other Strategic Priority Areas. The guidelines recommended that each country review the global actions in each SP and determine those with the highest priorities on a national basis. Currently, approximately

50 countries are at some active stage in the development of NSAP and approximately 25 report that NSAP are considered a high priority for the future (Beate Scherf, personal communication, 2012).

FAO Guidelines for *in vivo* and cryoconservation of AnGR

As a contribution to SP11 of the *Global Plan of Action,* FAO has developed two technical guidelines for conservation of AnGR. The types of conservation addressed in each guidelines document were divided according to the form of the stored germplasm, *in vivo* versus cryoconservation. FAO Guidelines on *cryoconservation of animal genetic resources*[1] were endorsed by the 13th Session of the Commission on Genetic Resources for Food and Agriculture (CGRFA) in 2011 and will soon be available in print. The draft FAO Guidelines on *in vivo conservation of animal genetic resources* will be presented at the 7th Meeting of the Intergovernmental Technical Working Group on AnGR in October 2012, with endorsement foreseen by the CGRFA at its 14th session in 2013. In these guidelines, FAO expresses agreement with the Convention on Biological Diversity that *in situ* conservation is generally the preferred approach and considers *ex situ* conservation to be an essential complementary activity.[2] *In situ* conservation ensures that an AnGR is maintained in a dynamic state, allowing it to evolve and adapt to changing production environments, including economic conditions. In addition, *in situ* conservation has advantages in contributing to sustainable utilization of rural areas, offering opportunities for rural development, maintenance of existing agro-ecosystems and conservation of rural cultural diversity. These possibilities are not available through most systems of *ex situ* conservation. However, the complementary role of cryoconservation is important, because it improves flexibility of the genetic system. Stored germplasm provides a source of genetic variability as insurance for changes in production conditions and protects this genetic diversity against threats from diseases, disasters and other catastrophic events. Ideally, all AnGR should have a collection of cryoconserved germplasm as a back-up, and the importance increases as the census size of the breed decreases.

National gene banks for cryoconservation of AnGR

Although development of national gene banks for cryoconservation of AnGR is highly recommended, specific details about the optimal system will vary from country to country. No single organizational and institutional system will be ideal for all situations. The best system will depend on a wide variety of factors, including the specific objectives for cryoconservation, the existing infrastructure, the technical capacity of available personnel, the species to be targeted, and the level of government and private support. It is recommended that a NSAP be in place to guide the development of a cryoconservation strategy, but countries should not allow at-risk AnGR to be lost while waiting for the establishment of their NSAP if this loss can be prevented by creating a gene bank.

Various stakeholders should be involved in establishing and operating a gene bank for cryoconservation of AnGR, including the state, individual livestock keepers and their breeders' associations and private breeding companies. The National Coordinator for the Management of AnGR should be kept apprised of all developments.

Cryoconservation programmes may have various objectives, but allowing for the reconstitution of an extinct breed will likely be the most common and will usually require more stored material than will other objectives, such as maintaining diversity within a small *in vivo* population. Semen will be the most common type of material stored, because of its

[1] http://www.fao.org/docrep/meeting/022/mb553e.pdf
[2] http://www.cbd.int/convention/articles/?a=cbd-09

lower cost and decreased requirements in terms of technical capacity (relative to embryos). Somatic cells offer a simple and effective low-cost opportunity to safeguard the genetic information of a given AnGR, but the eventual utilization (regeneration of live animals via cloning) involves high costs and technical capacity.

Establishment of a gene bank involves significant initial expenditures, but costs to equip a simple semen-processing and storage laboratory can be as low as 10 000€ if existing buildings can be used. Capital outlays should be viewed as an investment with costs amortized over the life of the gene bank. Particularly important aspects to consider when planning a gene bank are sufficient security and continuity of operations. Maintenance of duplicate samples stored at separate sites is highly recommended. Given the high value of the stored samples, health and sanitation should receive a high priority. OIE regulations for semen and embryos should be followed closely, especially if the stored germplasm may eventually cross national borders. Occasionally accepting a lower level of sanitation may be necessary, however, to obtain particularly valuable AnGR (e.g. through field collection), and these samples should be stored separately from the rest of the collection.

Accurate and efficient management of the data regarding the stored material is absolutely necessary. A database will be essential for managing routine gene bank operations such as quality-control testing, assessing current inventory and making decisions regarding management of genetic diversity. The database will serve as the primary tool for receiving, storing and exchanging information about samples in the collection. The input and outflow of information are of equal importance, so features that allow search and retrieval of data must be built into the system. Basic information required for each sample include a unique identifier, type of material (e.g. semen, embryo), dates of collection and storage, animal identification (preferably with parents), breed, breeder name and location (preferably GPS data). Ideally, more detailed genetic and phenotypic information about the animal will also be recorded. Various options are available for software to manage gene banking data, including Cryoweb[3] from Germany (Duchev et al., 2010) and the Animal-GRIN[4] software developed through collaboration among Brazil, Canada and the United States of America.

Gene banking involves various legal issues. The owner of the gene bank is unlikely to be the owner of all the animals providing germplasm, so the owner of the germplasm has to be agreed upon and documented, usually through a Material Transfer Agreement (MTA) between the two parties. Even if ownership is transferred to the gene bank, the MTA may include stipulations on how the material is to be used. Utilization of the gene bank material will usually involve a third party, for which a separate MTA is needed. In addition, a system of rules and procedures should be devised to regulate the distribution of gene bank material. Otherwise, the gene bank may risk the accidental depletion of supplies for a given AnGR.

FAO recently undertook a global study of the status of national gene banks (Boettcher and Akin, 2010). Persons from 90 different countries responded to the voluntary questionnaire. Fully operational gene banks were present in only 20 percent of the countries, but most of the remaining countries reported plans to establish national gene banks within the next five years. Some cryoconservation is taking place in countries without a formal national gene bank. Cattle were the most commonly cryoconserved species, followed by small ruminants. A lack of finances and low priority in national livestock policies were cited as the most common factors hindering the establishment or operation of gene banks.

[3] http://cryoweb.tzv.fal.de/
[4] Email to Harvey.blackburn@ars.usda.gov

International gene banks for AnGR

FAO supports the concept of international gene banks for AnGR. As previously noted, SP10 of the *Global Plan of Action* addresses international conservation strategies, which include developing networks of gene banks and regional or species level core collection of animal genetic diversity. International banks could play several roles: 1) to provide cryoconservation facilities for countries lacking national gene banks, 2) to provide back-up storage for national gene banks (i.e. a second location for security purposes), and 3) to store material from transboundary breeds.

According to the previously cited survey (Boettcher and Akin, 2010), international gene banks for AnGR are practically non-existent. Philosophical support for such banks was high, however, as opposition was expressed from only 10 percent of the countries. Among the factors contributing to the absence of international AnGR gene banks are a lack of funding, health regulations on international exchange of genetic material and a lack of consensus on procedures for operation of gene banks. International gene banking will invariably involve the movement of AnGR across borders and possibly changes in ownership. Material Transfer Agreements among countries will therefore be required. Signatory countries of the Convention on Biological Diversity need to ensure that any international transfer of AnGR is consistent with the terms of the Nagoya Protocol on Access and Benefit-Sharing

Conclusions

Gene banking can play an important role in a country's programme to manage and conserve its AnGR, especially as part of a NSAP and in concert with *in situ* conservation. Each country should develop its own gene banking strategy considering its particular conservation objectives, available infrastructure, technical capacity and available financial resources. FAO has developed technical Guidelines on *Cryoconservation of Animal Genetic Resources*[5]. National gene banks are a first priority, but international gene banks would be a valuable tool for safeguarding the world's AnGR.

References

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[5] http://www.fao.org/docrep/meeting/022/mb553e.pdf