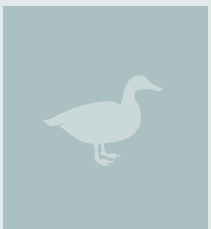
SECTION 10

Database and documentation


Database and documentation

Proper and accessible documentation is vital for the future use of any stored gene bank material. An essential aspect of this is to develop and implement a database that can be used to catalogue, summarize, query and retrieve the information needed to establish and operate the gene bank. Basic information about gene bank collections should be easily accessible without the need for any additional information from outside the database. The database will be essential for managing routine gene bank operations (e.g. quality-control testing, sample identification, sample location, current inventory, movement among collections and de-accession) and to support management decisions.

The database will serve as the primary tool for receiving, storing and exchanging information about samples in the collection. The outflow of information is just as essential as the input of information. Potential requestors of germplasm must be able to view the contents of the collection. To ensure broad access, the database needs to be linked to the internet. Internet access helps to promote awareness of the country's AnGR programme and makes it easier for users to access information and make use of the stored germplasm.

Databases for gene bank management can be very diverse. For example, a very basic information storage system can be set up using a spreadsheet program. More complicated databases can be developed by using computer software specifically designed for database construction. With such software, a broad array of databases, differing vastly in complexity, can be developed.

From the first phases of planning the gene bank, it is essential to recognize the important role that the database will play both in day-to-day management and in allowing potential users to access up-to-date information on the material in the collection.

COMPONENTS OF A GENE BANK INFORMATION SYSTEM

All databases have a tabular structure, with the tables linked to each other either through one-to-one relationships or through one-to-many relationships. Initial design of the database should involve close cooperation between gene bank managers, database developers/operators and potential user groups. This serves to ensure that users' information needs are identified and accounted for in the development of the database. Once needs have been identified, it is usual to develop a graphic scheme illustrating the various relationships within the database. As well as the database itself, a number of additional elements, necessary for inputting and extracting data, need to be put in place. These will include:

- data input screens that facilitate data input and mimic data-collection forms;
- data edit screens that allow changes to be made to data elements, and include automated features that allow changes to more than one record at a time;
- record review capability (facilitates the recall of individual or group records);

- capability to summarize elements in the database and calculate statistics that may be of interest to users or managers;
- capability to query the database, i.e. to extract specific pieces of information;
- output options that allow users to choose how the data they request are presented in tabular or graphical form, as well as the type of file to which the data are exported;
- data entry and edit control capability that allows database managers to control who can enter and edit data in the database; usually this is accomplished by making access to entry and edit functions password protected; and
- inter-operability – there may be a need or desire to link the gene bank database to databases operated by other national or international agencies and exchange information between them.

In addition to the items listed above, serious consideration must be given to the extent to which the information in the database should be made available on the internet. It may be decided that some information, such as where certain samples are stored in the repository, should not be made publicly available. Such information can be password-restricted or subject to some other form of access control. Generally, the access granted to outside users of a gene bank database will be "read-only".

When planning the construction of the database, gene bank managers should be aware of opportunities that exist to utilize database systems that have been, or are being, developed by other gene banking groups. Database development requires specific expertise that may not be available in all institutions or countries. Therefore, the use of existing databases and software packages or joint development of a database across countries may be a desirable option. In addition, using an existing database application will usually facilitate inter-operability. Examples of databases already developed by countries and regions to document cryoconserved material include the following:

1. Supported by the European Commission, the EFABISnet project developed the CryoWEB database tool (Duchev *et al.*, 2010). This tool has already been implemented in a number of European countries and is integrated with the EFABIS breed database. The CryoWEB database software is available under a free GPL license and can serve as a basis for further adaptation or development (see http://cryoweb.tzv.fal.de/).
2. The National Animal Germplasm Program in the United States of America, EMBRAPA of Brazil, and Agriculture and Agri-Foods Canada have joined together to develop an internet-based database for management of germplasm collections, which also offers the option of performing cross-country comparison of germplasm collections (see http://www.ars.usda.gov/Main/docs.htm?docid=16979).

DATABASE INFORMATION SET

In developing descriptors for the database, each country must determine what information it wants to maintain and what is needed to describe thoroughly the samples maintained in the repository. Tables 14 and 15 provide a list of minimum and recommended information fields that should be completed for every donor animal and sample in the gene bank. Breed-level information (final four rows of Table 14) needs to be collected once per breed, but should be directly available for each animal of each breed.

TABLE 14
Donor animal information: recommended minimum and additional database fields

Trait	Type	Minimum	Recommended	Comments
Animal identification				
Owner identification	Alpha-numeric	X		
Repository identification	Alpha-numeric	X		
Association identification	Alpha-numeric		X	
Markings			X	e.g. tattoo
Animal birth date	Alpha-numeric		X	
Sex	Alpha-numeric	X		
Source				
Breeder name	Alpha		X	Contract with original owner (if any) attached to the database
Owner name	Alpha	X		
Geographic location (geographical coordinates or mailing address)	Alpha-numeric	X		
Taxonomy				
Species	Alpha	X		
Breed	Alpha	X		
Population	Alpha	X		
Environment	Alpha		X	e.g. arid, semi-arid, humid, subhumid, temperate, subtropical highland
Management system	Alpha		X	e.g. pastoralist, ranching, mixed crop–livestock, small-scale landless, industrial landless
Phenotypic measures				
Body weights	Numeric		X	Birth weight, weaning weight, mature weight
Visual identifiers	Alpha-numeric		X	Colour, horns, photograph
Production measures	Alpha-numeric		X	Milk yield, fleece weight, litter size, etc.
Genetic measures				
Pedigree	Alpha-numeric		X	3 generations if possible
Genetic test results	Alpha-numeric		X	e.g. Halothane, Scrapie
Genetic markers	Alpha-numeric		X	Microsatellite, SNP
Breeding values	Numeric		X	e.g. production traits
Breed information				
Census data	Numeric		X	
Phenotypic descriptors	Alpha-numeric		X	Average weights
Genotypic descriptors	Alpha-numeric		X	Known genetic attributes
Production systems	Alpha-numeric		X	Production systems where the breed is prevalent

TABLE 15
Sample information: recommended minimum and additional database fields to be associated with animal identification

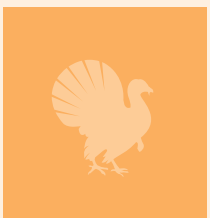
Trait	Type	Minimum	Recommended	Comments
Collection				
Date				
Location				
Sample quality				
Semen				
-Temperature at arrival in lab	Numeric	X		
-pH at arrival in lab	Numeric	X		
-Pre-freeze motility	Numeric		X	
-Post-thaw motility	Numeric	X		
Embryo				
Grade before freezing				
Stage of development				
Quality after freezing				
Straw information				
Identification	Alpha-numeric	X		
Freeze date	Numeric	X		
Species	Alpha-numeric	X		
Breed	Alpha-numeric	X		
Storage information				
Kind of straw or pellet or else	Alpha-numeric	X		
Tank	Numeric	X		
Placement in tank	Numeric	X		
Collection method				
Semen	Alpha-numeric	X		
Embryo	Alpha-numeric	X		
Oocyte	Alpha-numeric	X		
Somatic cells	Alpha-numeric	X		
Freezing protocol used*				
Semen	Alpha-numeric	X		Detailed protocol attached to the database
Embryo	Alpha-numeric	X		
Oocyte	Alpha-numeric	X		
Somatic cells	Alpha-numeric	X		
Sample ownership				
Semen	Alpha-numeric	X		
Embryo	Alpha-numeric	X		
Oocyte	Alpha-numeric	X		
Somatic cells	Alpha-numeric	X		
Sample sanitary status				
Semen	Alpha-numeric	X		Details of diagnostic tests attached to the database
Embryo	Alpha-numeric	X		
Oocyte	Alpha-numeric	X		
Somatic cells	Alpha-numeric	X		

* Thawing instructions may be included as additional information.

Obtaining these descriptors may be difficult, and in some situations some of them may not exist. A potential solution is to obtain information while performing field collections. One such approach is to develop survey sheets that germplasm collectors can use to obtain the required information by interviewing livestock keepers or can be given to the livestock keepers to complete and return.

SECTION 11

Legal issues – contracts and access



Legal issues – contracts and access

In the development of country-based gene banks there may be need for various types of agreements covering the acquisition of germplasm or tissue and the dispersal of the materials when they are requested by potential users. The agreements should delineate the rights and responsibilities of the gene bank, the users of the gene bank's germplasm/tissue and (where relevant) the donors of the samples. Because of the potential legal ramifications, the gene bank must have clear policies and procedures for drawing up such agreements. Such policies may be established by the gene bank management or may be established at a higher level, such as through national legislation. For example, in the case of United States of America's genetic resources system, the Congress enacted legislation[6] stating that material in the public collection will be distributed to requestors free of charge. With such a policy in place, the gene bank has clear guidance on one aspect of germplasm distribution. However, as described in this section, such a policy only covers one aspect of germplasm release. Each country needs to establish a clear set of criteria for all aspects of acquisition, storage and use of gene bank material.

In developing policies and general agreements for acquiring and dispersing germplasm, a suggested guiding principle is that these instruments should facilitate the sustainable use, development and conservation of AnGR and the enhancement of the country's livestock sector. In other words, conditions placed upon the acquisition or release of germplasm should not be so restrictive as to put valuable AnGR at risk by impeding the development of germplasm collections or the use of the material stored in the repository.

STRUCTURE FOR HANDLING AGREEMENTS

Gene banks have to contend with a range of different types of agreements concerning the acquisition and release of germplasm. Because of the long-term nature of the gene bank's mission and its close relationship with the livestock sector, it may be useful to establish an advisory committee of interested parties not employed by the gene bank. This committee may or may not be the same as the National Advisory Committee on AnGR (see guidelines on the *Preparation of national strategies and action plans for animal genetic resources,* FAO, 2009). The committee's mission would be to provide advice and recommendations on policies for acquiring and distributing germplasm. It would be able to provide the gene bank with advice on how contracts and, other agreements and policies, can be formulated in such a way as to garner support from industry and government.

[6] Public Law 101-624-Nov. 28, 1990 (http://awic.nal.usda.gov/public-law-101-624-food-agriculture-conservation-and-trade-act-1990-section-2503-protection-pets).

ACQUIRING GERMPLASM

Depending on the country, the exchange of AnGR may not be regulated by specific legislation but by more general property rights. This is often the case because, historically, in most countries individual livestock have been primarily considered private property (of an individual, group of individuals or company). As a result, owners have been able to breed and improve their livestock as they have deemed appropriate. Furthermore, livestock owners have, for centuries, generally been free to buy and sell animals for genetic improvement purposes (Wood and Orel, 2005). As biotechnologies such as AI have emerged, they have been used for marketing the genetic improvement breeders have made. To facilitate commercial exchange, buyers and sellers have used a variety of agreements and private contracts. Similarly, because the genetic material that gene banks target for inclusion in their collections will generally be owned by individual livestock breeders, agreements transferring ownership from the breeders to the gene bank will usually be required. Alternatively, the breeder may prefer an agreement that facilitates the holding of the germplasm by the gene bank without a transfer of ownership.

As a result of pre-existing practices for the exchange of AnGR within the country, gene bank managers may have to negotiate an arrangement with each owner from whom they wish to acquire germplasm samples. Such arrangements can take several forms:

1. The gene bank may buy the animal from the owner, thus obtaining unconditional rights to the AnGR.
2. The livestock owner may donate the sample of germplasm to the gene bank, and by doing so give up all claims to the germplasm donated.
3. The livestock owner may charge a fee for access to the animal and the germplasm collected. By doing this the owner may or may not forego further claim(s) on the germplasm collection.
4. The livestock owner may maintain ownership of the germplasm for a specified period of time while it is in the gene bank (also known as an embargo), after which the germplasm becomes the property of the gene bank. Such an approach can protect breeders, for a period of time, from competitors that may want to acquire the samples for the purpose of gaining an advantage. If the owners do not want to forego their rights to germplasm stored in the gene bank, managers have to determine whether material stored for a long time (and replaced with newer samples) should remain in the gene bank or be returned to the owner.

These approaches (particularly 3 and 4) may require the gene bank to formulate contracts – generally referred to as material transfer agreements (MTAs) or material acquisition agreements – for the transfer of the germplasm. The following elements are suggested for inclusion in such an MTA.

Property rights. The ownership of the cryopreserved material should be specified. The rights of the owner (donor) and the gene bank should be defined.

Costs of collection. The donor and gene bank will need to agree about the costs associated with collecting and freezing the germplasm.

Storage. There may be cases in which the gene bank regards particular germplasm as important to store, but has neither clear ownership of this material nor the potential to

acquire such ownership. In such circumstances, the gene bank may wish to arrange for the germplasm owner to pay a storage cost.

Access. Depending upon the particular interests of the donor, the MTA may need to stipulate specific conditions for accessing the germplasm (see arrangement 4 above). The simplest approach is to structure the agreement in such a way that any requestor must first obtain permission from the donor before the material is released. By doing this, any issues that may arise regarding the further use of the material will not involve the gene bank, thus maintaining its position as a neutral entity. Serious attention should be given to the objective of ensuring that the release of gene bank material does not harm the competitiveness of the breeder/provider of the germplasm.

Intellectual property rights. If the gene bank is established as a public good, research results obtained using the material in the gene bank should be publicly accessible without any claims on intellectual property. Such a position will also minimize or eliminate the gene bank's involvement with any type of benefit-sharing arrangements.

Veterinary/sanitary issues. The collection, transfer and use of germplasm may be affected by national health policies, and the gene bank will need to take these into account in the process of acquiring germplasm. The health status of the donor animal and the cryopreserved genetic material should be defined in the MTA. The MTA should contain a list of diseases for which the animal has been tested at the time of collection.

Storage sites and quality assurance. MTAs should include a short statement indicating that the gene bank will follow a set of best practices to ensure that the viability of the samples is maintained.

Data protection. The provider and gene bank may wish the MTA to include stipulations regarding what information about the cryopreserved material and the donor will be made publicly available.

ACCESS TO THE GENE BANK'S COLLECTION

In general, there are three primary reasons for accessing stored material:

- national public need;
- non-research related breeding of animals by non-government organizations or private entities; and
- research.

The type of use will determine from which collection category (see Section 3) the genetic material will be taken.

Requestor's actions

Potential users of gene bank material should initiate the process by submitting a written request outlining their need for germplasm. The written request should provide the following information about the germplasm needed and its intended use:

- legal entity and affiliation of the applicant;
- type and quantity of genetic material requested:
  - species;
  - breed;

  - number of animals;
  - name and registration numbers, if specific animals are requested;
  - type of germplasm;
  - quantity of germplasm;
  - justification for the type of germplasm requested;
- accurate information on the intended use:
  - for breeding purposes – a justification of the need to access stocks from the gene bank; this justification may need to include information on the structure, effective size and performance of existing populations;
  - for accessing DNA for research purposes – details about the project including objectives, collaborators and sponsors;
- types of benefits that could arise from obtaining access to the resources;
- the competence of the requestor to use the genetic material properly and maximize success; and
- agreement or waiver by the requestor to accept any risks associated with the health status of the genetic material and to take any subsequent measures necessary to avoid the spread of diseases.

For convenience, the gene bank may decide to prepare a standard form for requestors to compile, based on the above list.

The information provided will help the gene bank manager to decide whether or not release of material is justified and beneficial for the national programme of AnGR management. The manager may also need to determine whether the consent of the germplasm provider is needed, based on the terms of the MTA under which the germplasm was provided. When germplasm is to be used for generating live animals, the gene bank may want to consider requesting that the user redeposit germplasm from the resulting progeny. For germplasm used in DNA studies or for generating live animals, it is recommended that the recipient be required to submit any phenotypic or genotypic data arising from the project to the gene bank for entry into a publicly accessible database. The submission of such information to the gene bank can take place after it has been published.

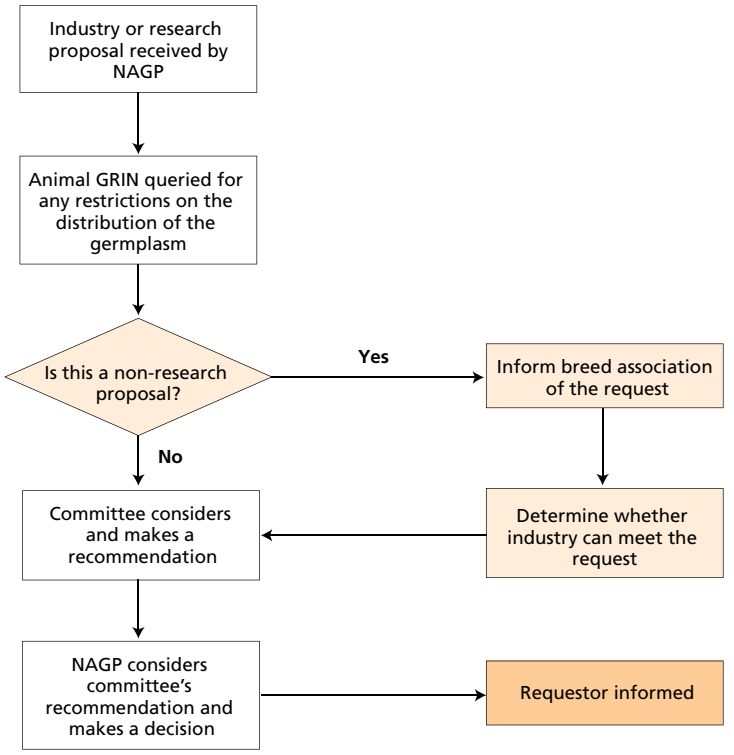
Meeting the request

Once a request for germplasm or tissue has been received and its merit evaluated, the gene bank must also determine whether it has sufficient quantities of the material available to fulfil the request without compromising the core collection (see Section 3). If the requested material is also available in the commercial sector, the cryobank should not allow use of its material.

National need. In the case of national need, the government may decide to withdraw germplasm from the relevant categories of the collection. In such a situation, the gene bank may want to convene a group of in-country experts and industry-related persons to provide recommendations and assist in facilitating the use of the germplasm.

Non-research and research requests. Non-research requests are usually those made by a segment of the livestock industry for the purposes of resolving a genetic resource issue. Requests for research purposes may come from either the public or the private sector.

FIGURE 16
Reviewing requests for animal germplasm and/or tissue – an example from the United States of America



Note: NAGP = the National Animal Germplasm Progam of the United States of America; GRIN = Germplasm Resources Information Network; "committee" refers to the advisory group that has the mandate to make decisions on release of material from the gene bank.

Source: adapted from Blackburn (2009).

The gene bank should establish a review process for dealing with both non-research and research requests. As an example, Figure 16 details the process used by the National Animal Germplasm Program in United States of America to review such requests (Blackburn, 2009).

INTERNATIONAL TRANSFERS OF GERMPLASM

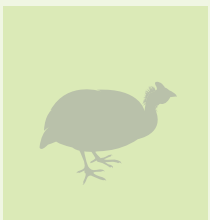
The primary mission of a national gene bank is to secure the integrity of national AnGR. Therefore, its operation and practices should be firmly established under the country's laws. Opportunities may exist to exchange germplasm across national boundaries. In such cases, the primary regulations involved are those related to animal health. The OIE has established protocols for transferring germplasm from country to country. These protocols have been used by member states of the World Trade Organization (WTO), in line with the Agreement on the Application of Sanitary and Phytosanitary Measures, to establish national measures

consistent with internationally "harmonized" standards, guidelines and recommendations. Aside from the need to conform to animal health regulations, the exchange of AnGR is mainly a matter of transferring private ownership (by private law contracts and customary law). In addition, 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[7].

[7] http://www.cbd.int/abs/text/

SECTION 12

Capacity building and training


Capacity building and training

The development of sustainable conservation programmes is only possible if it is combined with the development of human resources, institutions and long-term organizational support. Well-trained researchers and decision-makers are critical for creating awareness of AnGR-related problems and for implementing programmes to conserve and sustainably use AnGR.

Strategic Priority Area 4 of the *Global Plan of Action for Animal Genetic Resources* (FAO, 2007b) calls for development of a strong and diverse skills base to implement the *Global Plan* at national and international levels. The Convention on Biological Diversity calls for access to, and transfer of, technology (Article 16)[8]; exchange of information relevant to the conservation, management and use of biological diversity, including information on research, training, surveys and specialized knowledge (Article 17)[9]; and technical and scientific cooperation through, where necessary, appropriate international institutions, with special attention to capacity building (Article 18)[10].

The most important task in improving knowledge of AnGR and their management is to make sure that all major aspects of conservation and sustainable use are integrated into regular university curricula worldwide. Consideration should be given to both local and global aspects of animal production, given the importance of interaction among different genotypes and environments and among different species (including wild species and plants and micro-organisms) within the same environment. Students should be introduced to the agro-ecosystem approach to agriculture and livestock production. Closer collaboration between countries, both developed and less-developed, can be promoted via extended exchange programmes for students and teachers (Malmfors *et al.,* 1994). Vangen and Mukherjee (1994) suggested an integrated approach to university teaching of animal breeding and the genetics of conservation, particularly at postgraduate level. Training courses should also be organized for national administrators and heads of departments involved in policy decisions, industry personnel and facilitators of conservation programmes. The courses should aim to promote awareness of the importance of AnGR and explain the major steps in their characterization, documentation, conservation and improvement.

Including the following topics in higher education courses on AnGR will increase awareness and understanding of the importance of conserving and properly managing these resources:

Global threats and opportunities in the management of animal genetic diversity. This topic should cover the evolution and history of domestic species and breeds; the concepts of the breed and the population; the characteristics of animal populations in various

[8] http://www.cbd.int/convention/articles/?a=cbd-16

[9] http://www.cbd.int/convention/articles/?a=cbd-17

[10] http://www.cbd.int/convention/articles/?a=cbd-18

parts of the world; and present economic development trends. Livestock production systems in various regions of the world and the prospects and constraints facing different animal populations in relation to environmental and socio-economic conditions should also be addressed.

Understanding genetic diversity and factors affecting genetic variation. Education in factors affecting the dynamics of genetic variation in small populations is of great importance. The concept of the rate of inbreeding (and hence N_e) and its relation to the dynamics of genetic variance (and other measures) over time is important.

Characterization and documentation of animal populations. In any programme aiming to conserve AnGR for future utilization, as well as in other aspects of AnGR management, characterization and documentation of living populations and any cryoconserved material is extremely important. This should include the distribution of the populations, and their characteristics in relation to defined environments. It is also important to know how to monitor population changes and measure genetic relationships between breeds and to organize and utilize databanks.

***Ex situ* strategies and methods for conservation of animal genetic resources.** Courses on cryoconservation should cover methods for storing frozen semen, embryos, oocytes, cell cultures and DNA, as well as objectives for conservation programmes, methods of collection, sample sizes and record keeping.

Reproductive biotechnology. Having personnel who have received training in reproductive biotechnology will allow countries to undertake cryoconservation programmes independently. Furthermore, it will allow developing countries to take advantage, via technology transfer, of the extremely rapid development that is occurring in the field of advanced biotechnology in developed countries.

Sanitary and legal issues related to access and exchange of germplasm. Many aspects of AnGR management, including the operation of gene banks, require awareness and knowledge of national and international policies affecting the exchange of AnGR.