AN ADAPTABLE MANAGEMENT SUPPORT SYSTEM FOR
NATIONAL GENE BANKS

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INTRODUCTION
With the convention on biodiversity (UNEP, 1992) the focus on animal genetic resources has
gained much political attention. There are different possible strategies for the conservation of
domestic animal diversity: 'in situ' and 'ex situ'. In general, we prefer in situ conservation
because animals are conserved alive and often in their 'natural' environment. However, for
added security e.g. during disease outbreaks, 'ex situ' conservation is a very important strategy
too (Oldenbroek, 1999).

Besides formal gene banks many other cryogenic collections exist at artificial insemination
(AI) stations and research institutes, that do not have the formal status of a gene bank. Because
very little information exists on the content of these stores, no overview is possible on a
national or even breed level. In short, the important documentation aspect of 'ex situ'
conservation is lacking to a large degree. However, to promote usage of genetic material from
the gene bank in the short or long term information is needed. In Europe, there are two
databases available on the Internet, which contain information about all European breeds of
domestic animals. One is located at FAO, Rome. The other one is built under the auspices of
the European Association for Animal Production (EAAP), located in Hannover. Both databases
give mainly information about live populations, in other words 'in situ' breeding populations.
Because deep frozen embryos from rare breeds have a similar status of importance as live
animals, the recording mechanism should be similar for both. With the need for regional or
national monitoring of genetic resources not only for in situ populations but also for gene
banks, the requirement to report gene bank stocks in an aggregate manner to supra national
bodies like FAO, the current project got under way as joint effort between the Netherlands,
Germany and FAO.

THE SYSTEM DESIGN
The management system to be developed is supposed to be adaptable to any gene bank, free of
license fees, scalable to small and large systems, be accessible over the Internet, and in a
uniform way accommodate any number of species, all the relevant tissues ranging from semen,
embryos, oocytes, blood, somatic tissues to DNA. It should allow to include data from
different organisations into one database, support the management of potentially distributed
gene banks and facilitate aggregate reporting of gene bank stocks. Many of the above
requirements are covered as design features of APIIS, which is a framework for adaptable
platform independent information systems (Groeneveld, 1999 and 2002). Within this
framework a management support system for gene banks in animal agriculture (CryoIS) was
developed.
Organisational Background and Parties Involved. In the Netherlands, in 1992, the Dutch Foundation for the Conservation of Animal Genetic Resources (gene bank) was set up. The gene bank aims at conservation of genetic characteristics from the past, the present and the future, through sampling, characterisation, documentation and monitoring of genetic material of farm animals of Dutch origin. At the moment, the Dutch Gene Bank for Farm Animals contains semen of cattle, horses, sheep, and pigs, both commercial and rare breeds. The Ministry of Agriculture, Nature Management and Fisheries, the breeding organisations, the breeding industry, and the Dutch Rare Breeds Foundation are involved with these 'ex situ' conservation activities. Since the gene bank collection for farm animals in the Netherlands is growing, there is a strong need for a database, which should first of all be useful for the management of the Gene Bank, currently at the Institute for Animal Science and Health in Lelystad, the Netherlands. On the other hand, there is a common interest in European countries, and strongly supported by FAO, to develop an information system, from which the program code could be used and adjusted by interested persons involved with gene banking. With this objective, the Institute for Animal Science and Animal Behaviour in Mariensee, Germany, and the Institute for Animal Science and Health started a cooperation project, which lead to 1) an operational system for the Gene Bank at ID-Lelystad and 2) open source program code, which can be downloaded, used and adjusted for specific purposes by third parties.

The General Data Model. As stated above, the general model is to cover all cryogenic materials (semen, embryos, oocytes, blood, somatic tissue and DNA) from all species used in animal agriculture. The reason for adding somatic cells and DNA resides in potential future possibilities: perhaps it will be possible to reconstitute living animals by cloning from these materials. Furthermore, it is felt that DNA from today’s animals may be of use for future analysis of genetic variability.

To achieve a generalised procedure for dealing with any type of tissue, the "tissue equals animal strategy" was followed. This means that all tissues are treated as if they were "animals". While this may seem plausible for embryos and even somatic cells (both are diploid) this may not be so for semen and oocytes. However, even here taking semen as an "animal" works operationally well.

This allows the use of APIIS which has been developed as a database system for individual animal records (amongst others). As such, it has a set of mandatory tables facilitating the use of any external numbering system, a general treatment of codes and an address, persons section. For a full description see Groeneveld (2002). A graphical presentation of mandatory tables is given in figure 1 by the six shaded boxes on the left circled by solid lines.

For the intended use for a national cryo database for all species and very different numbering systems the table TRANSFER is of central importance. It translates any external animal identification (subject to some constraints) into an internal number used throughout the database.
THE IMPLEMENTATION OF THE SPECIFIC DUTCH SYSTEM

After stating the generally applicable requirements, the data specific to the system to be implemented need to be analysed. The development of the data model followed the data stream (DS) strategy as outlined in Groeneveld (2002). A DS is defined as a group of data elements recorded at one time for an object of interest (like an animal or embryo or oocyte). Typically, a DS finds its physical representation in a paper form that is used for data recording. The sum of all data elements from all data streams constitute the total sum of attributes to be normalised in a database. Extending the scope of the database to other types of material leads to an addition of PROPERTIES_ tables which hold the material specific data as indicated by the stack in the upper right corner of figure 1.

The data streams and inputs. Table 1 gives the data streams for the Dutch gene bank at this point for semen only, comprising 12 paths for entering data (DS01-DS12).

The first three are general to the system and cover the management of codes, addresses and the definition of the gene bank properties. The latter comprises the definition of physical storage places i.e. their location, number and identifications of the tanks. If new semen is to be added to the gene bank the graphical user interface programs (GUI) for DS07 and DS08 will be used. Here, data about the species, the breed, the animal identification, the organisation involved, the gene bank location, the number of doses and semen quality parameters are recorded. With this facility, semen stocks from all members of the Dutch Foundation for the Conservation of Animal Genetic Resources can be administered covering the species cattle, pigs, sheep and horses using the partners’ own identification system. DS09, DS10 and DS11 deal with the utilisation of semen following the procedure which has been developed by the Foundation.

Figure 1. The CryoIS Database Model
The first 11 datastreams are entered into the cryo database interactively via GUI programs but DS12 is a batch and not an interactive task as indicated in column 3 in table 1. This DS originates in the production databases of the herdbooks, comprising full pedigrees, performance and breeding value information.

Table 1. Datastreams of the Dutch Cryo System

<table>
<thead>
<tr>
<th>Data Stream</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS01</td>
<td>Managing codes</td>
<td>GUI</td>
</tr>
<tr>
<td>DS02</td>
<td>Participating units - partners, addresses</td>
<td>GUI</td>
</tr>
<tr>
<td>DS03</td>
<td>Genebank properties</td>
<td>GUI</td>
</tr>
<tr>
<td>DS04</td>
<td>Entering a new animal</td>
<td>GUI</td>
</tr>
<tr>
<td>DS05</td>
<td>Changing animal status-numbers, unit</td>
<td>GUI</td>
</tr>
<tr>
<td>DS06</td>
<td>Raising and semen collection – contract</td>
<td>GUI</td>
</tr>
<tr>
<td>DS07</td>
<td>Delivering genetic material – semen</td>
<td>GUI</td>
</tr>
<tr>
<td>DS08</td>
<td>Storing genetic material - storage data</td>
<td>GUI</td>
</tr>
<tr>
<td>DS09</td>
<td>Using genetic material – request</td>
<td>GUI</td>
</tr>
<tr>
<td>DS10</td>
<td>Using genetic material – contract</td>
<td>GUI</td>
</tr>
<tr>
<td>DS11</td>
<td>Using genetic material - taking out from stock</td>
<td>GUI</td>
</tr>
<tr>
<td>DS12</td>
<td>Adding Animal data from herdbook</td>
<td>BATCH</td>
</tr>
</tbody>
</table>

Outputs. Statistics on the stocks of the gene bank is readily available and can be broken down in any manner like species, breeds, dates and number of doses of semen. This also facilitates real time monitoring of the actual stocks in the gene bank as required by super national databases like the EAAP database and FAOs DAD-IS system. Transfer and input to these systems has been tested and will become operational on a regular basis very soon.

IMPLEMENTATION STATUS AND AVAILABILITY
So far, information on the national gene bank has been stored in a number of files. These were loaded into CryoIS using the procedure for loading historic data developed in APIIS. While having been developed under Linux, CryoIS now runs under Windows NT at the Institute for Animal Science and Health (ID-Lelystad) in the Netherlands. The front end of CryoIS can be run on any machine of the local area network connecting to the central database which is the public domain relational database management system PostgreSQL. As with APIIS also CryoIS is put into the Open Source and is therefore freely available at www.tzv.fal.de/~eg.

REFERENCES