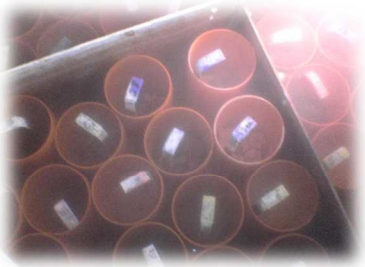
IMAGE
Innovative Management of Animal Genetic Resources

European Commission | Horizon 2020 European Union funding for Research & Innovation

Inventory and mapping of European animal genetic collections






INSTITUT DE L'ELEVAGE idele

Table of contents

Authors:

Anne-Sophie Passemard, Louise Joly, Delphine Duclos & Coralie Danchin-Burge – IDELE

Special thanks to:
Michèle Tixier-Boichard, Sipke Hiemstra and Óscar Cortés Gardyn for their useful comments

INTRODUCTION

The IMAGE (Innovative Management of Animal Genetic Resources) project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 677353. IMAGE aims to enhance the use of genetic collections and to upgrade animal gene bank management by further developing genomic methodologies, biotechnologies and bioinformatics for a better knowledge and exploitation of animal genetic resources. One of its first goals (Work Package 2, Task 2.1) was to obtain detailed information about the diversity of germplasm and genomic collections across Europe. Information collected by the survey will be made accessible through the IMAGE website and will be used for further analysis in the IMAGE project. This report is presenting the survey's main results.

1. SURVEY

1.1. METHODOLOGY

Data were collected through an online survey that was sent to a list of institutions holding or managing a collection of farm animal genetic resources in Europe. For this survey, two types of genetic collections were distinguished:

1) **Germplasm collection,** which is a collection that stores biological samples of reproductive material (semen, embryo, etc.)

2) **Genomic collection**, which is a collection that includes other biological material (DNA, blood, tissue etc.).

The list of institutions and contact details was provided through the network of IMAGE Consortium partners (www.imageh2020.eu/) and the European National Coordinators for animal genetic resources during the fall of 2016. Answers from the survey were collected till mid-April 2017. The whole questionnaire is available in the appendix (p. 34).

The survey was elaborated by a working group of experts involved in the IMAGE project. This working group included the following persons: Anne-Sophie Passemard, Coralie Danchin, Delphine Duclos, Sipke Joost Hiemstra, Maria Wurzinger, Elzbieta Martyniuk, Beate Berger, Alessandra Stella, Gabor Meszaros, Michael Klaffenboek and Johann Soelkner.

The 182 questions covered basic information (such as name and address of the organization involved), elements about the collection itself (species, breeds, type of material stored), indications on how the collection was managed (including security backup, sanitary requirements, database set up and existence of quality management system), conditions of access to the resources (including questions about the implementation of the Nagoya protocol on Access and Benefit Sharing). All the information gathered with the survey were stored in an Access database.

1.2. RESPONDENTS

A total of 61 organizations representing 21 countries returned the questionnaire (Table 1; Figure 1). The majority of the answers (55 %) came from a single institution per country, which were hosting in some cases both a germplasm and genomic collection. On the other hand, as many as 29 different organizations answered the survey for Spain. In this country, several AI companies have both a commercial and a conservation role for genetic resources and they do not necessarily distinguish

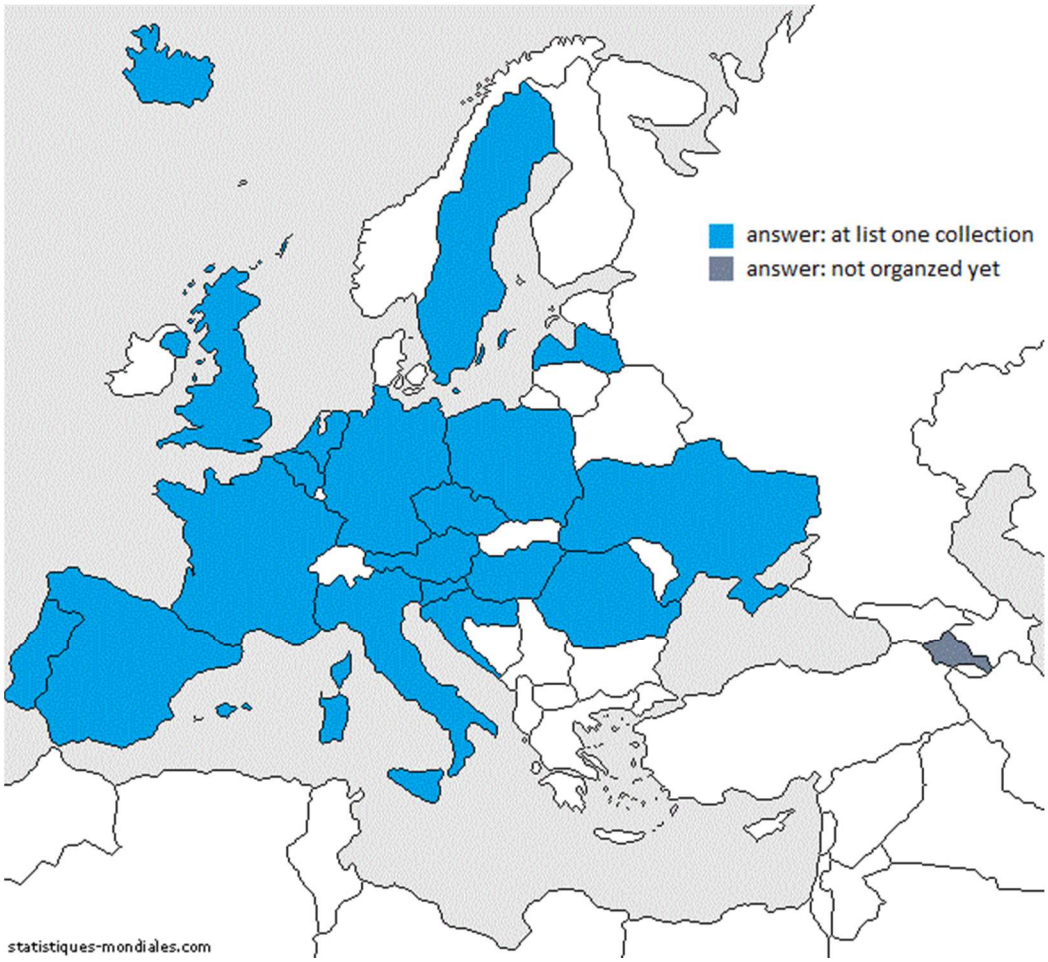
between these two activities. For this reason we specified their objectives in the appendix. In the case of a dual collection, each collection is counted as one in Table 1.

Table 1 : number of answers per country and collection type

Country	**Number of answers**	***Incl. germplasm collections***	***Incl. genomic collections***
Armenia	1 (No collection)	*0*	*0*
Austria	1	*1*	*1*
Belgium	1	*1*	*0*
Croatia	1	*0*	*1*
Czech Republic	2	*1*	*2*
France	4	*2*	*3*
Germany	4	*4*	*1*
Hungary	2	*2*	*2*
Iceland	1	*1*	*1*
Italy	3	*2*	*3*
Latvia	2	*2*	*2*
Montenegro	1	*0*	*1*
Poland	1	*1*	*1*
Portugal	1	*1*	*0*
Romania	1	*1*	*1*
Slovenia	1	*1*	*1*
Spain	29	*26*	*7*
Sweden	1	*1*	*0*
The Netherlands	2	*1*	*2*
UK	2	*2*	*0*
Ukraine	1	*1*	*1*
Total	**62**	***51***	***30***

We can consider that we have a good coverage of Europe (Figure 1), however unfortunately several European countries did not provide answers.

Figure 1 : Map of the countries which filled the IMAGE questionnaire



1.3. QUALITY INDICATORS

Since it was not required to answer all the questions, the content of the database is quite heterogeneous. When a question was not mandatory, it was decided to implement a quality indicator that will be found at the beginning of each paragraph by the letter QA (Quality of the Answer) with a percentage next to it representing how many surveys were complete for this question. It will give an insight on how relevant the questionnaire is for this particular topic. Also, since half of the collections that answered were from Spain, we tried to make sure that the answers we had were relevant across countries, by adding a "country representation" (CR) indicator.

2. CHARACTERIZATION OF THE GENETIC COLLECTIONS ACROSS EUROPE

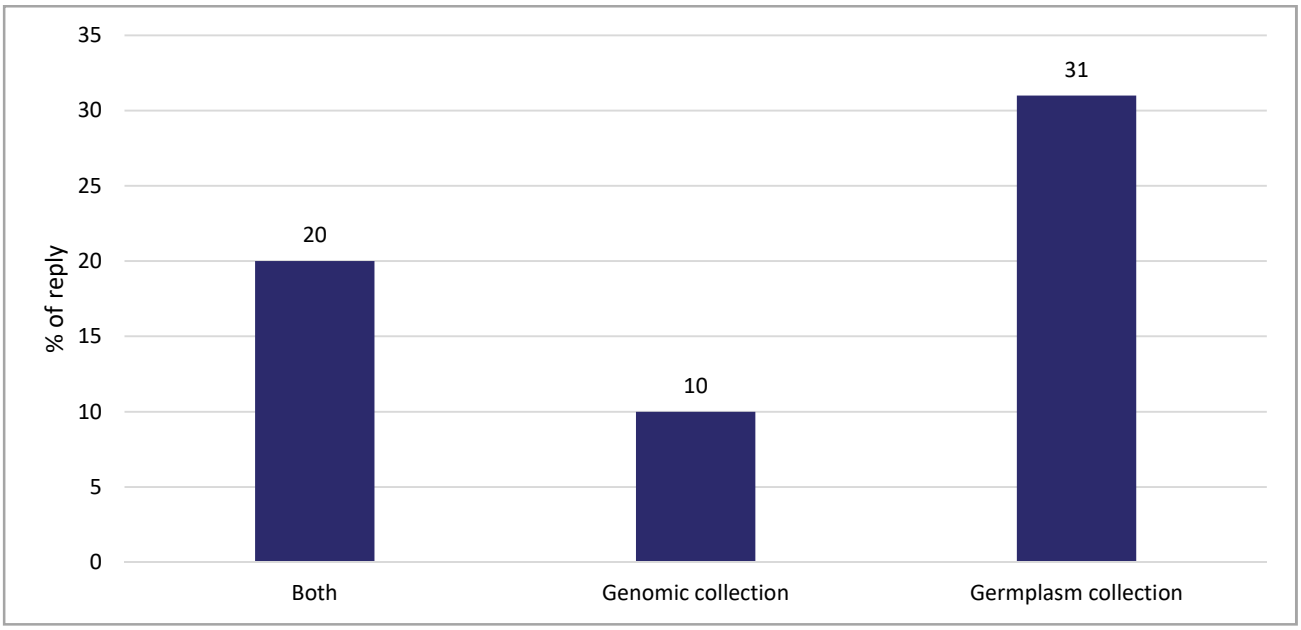
2.1. COLLECTIONS TYPE

As shown by Table 1, the total number of answers is equal to 30 for genomic collections and 51 for germplasm collections. There are 20 different organizations that are holding both a germplasm and a genomic collection (Figure 2). Based on previous investigations (including the one carried out by Hiemstra et al., 2014[1] for the European Genebank Network - EUGENA; FAO 2015) the germplasm collections' coverage seems fairly accurate. On the other hand, no equivalent work was ever done for

[1] Hiemstra S.J., Martyniuk E, Duchev Z. and Begemann F. et al. (2014) European Gene Bank Network for Animal Genetic Resources (EUGENA)- 10th World Congress of Genetics Applied to Livestock Production

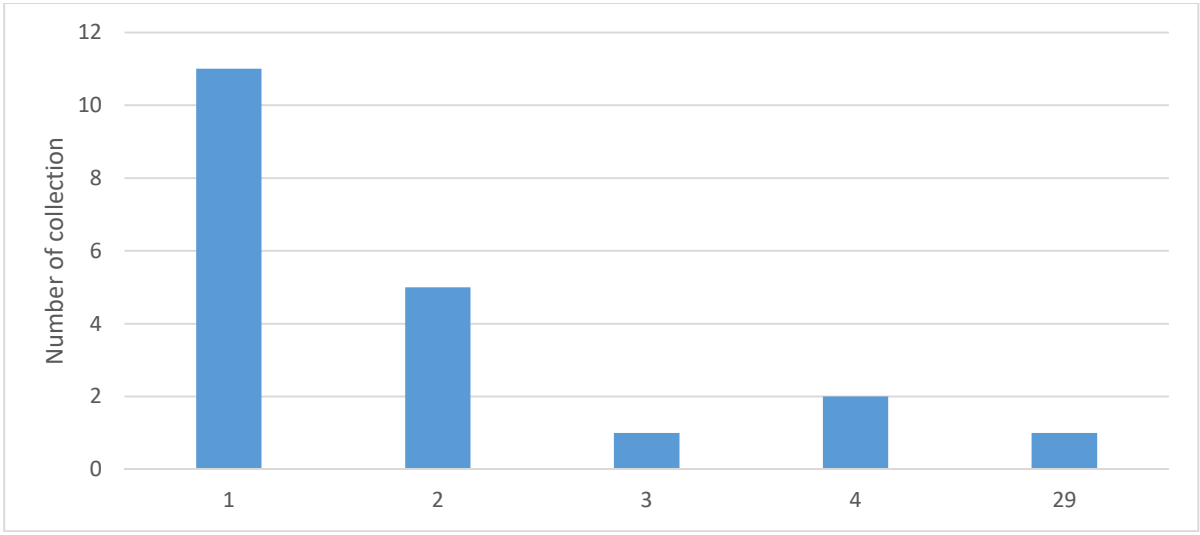
genomic collections. We would expect the number of genomic collections across Europe to be actually much higher. The questionnaire was not answered by a great number of institutes and universities keeping genomic collections and many researchers that are keeping DNA samples for their projects might not consider themselves to be collection managers.

Figure 2 : Percentage of the different collections type



The majority of the countries (55%) have only one genetic collection (Table 1, Figure 3). Among the eleven countries with only one organization holding a collection (according to the survey), six of them have both germplasm and genomic material, while three have just germplasm material and two just genomic material.

Figure 3 : Number of genetic collections per country



2.2. INSTITUTIONS MANAGING THE COLLECTIONS

Collections are mostly managed by a public research institute or university (Table 2). Very few genetic collections are managed by a public-private partnership. Moreover, this type of managing entity is only represented for germplasm collections. Overall 82% of genetic collections are managed by a public institution. The percentage is equivalent when the collections from Spain are removed. However it has to be stated that fully private collections exist but were not targeted in this survey.

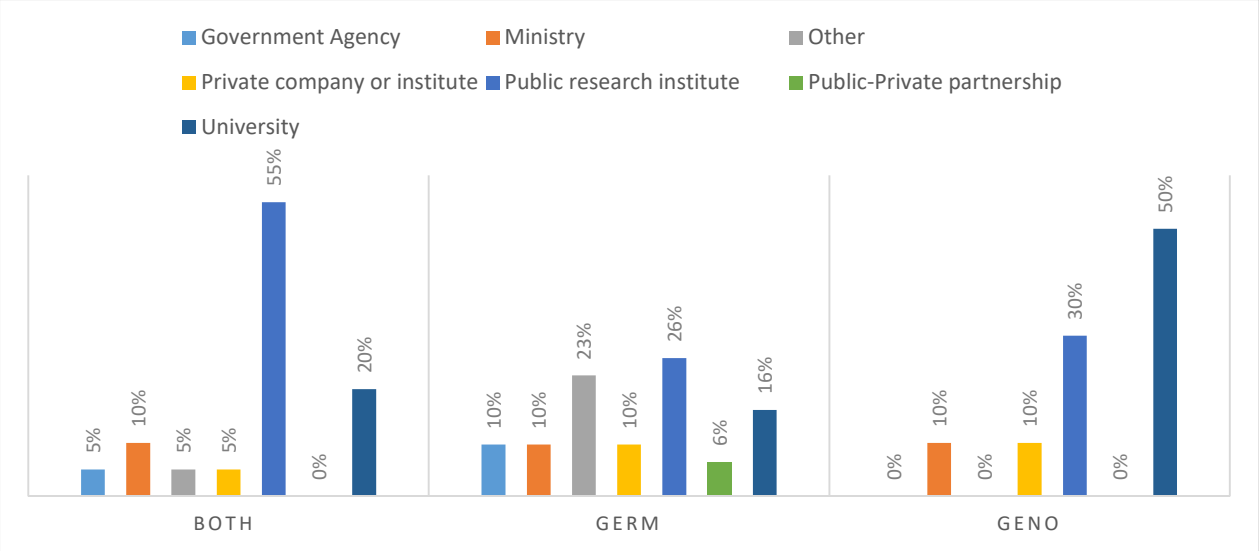
Table 2 : Type of managing entity

Entity	% of reply
Government Agency	7%
Ministry	10%
Private company or institute	10%
Public research institute	38%
Public-Private partnership	3%
University	23%
Other*	10%

** Three different Spanish autonomous entities, one private person (Germany), two charities (UK)*

A more detailed analysis shows that there is more variability in the managing entity for germplasm collection compared to genomic collections (Figure 4).

Figure 4 : Institutions managing the collections by type of collection

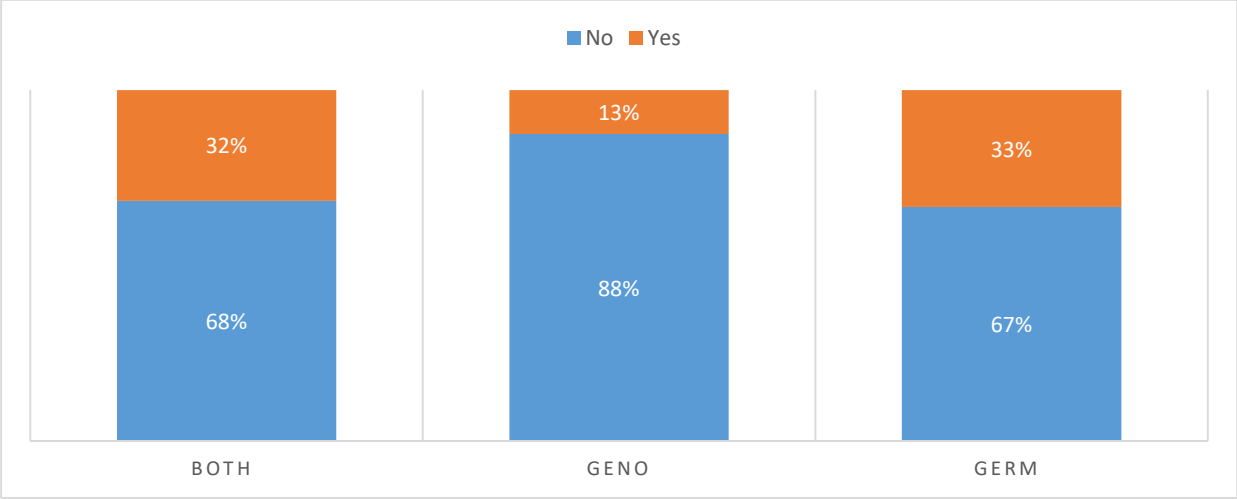


2.3. COLLECTIONS DUPLICATIONS

QA: 87%	CR: 90%

The duplication of a collection consists of storing a part of the collection in a backup site. In Europe, 30% of the genetic collections have duplicated their collection. However, there is variability between the different types of collections. Indeed, whereas the percentage of collections duplicating their collection exceed 35% for germplasm collection and collections with both type of material, this percentage drops to 11% for genomic collections.

Figure 5 : Collections duplications



Among the genetic collections that have a backup site, a mere 13% fully duplicate their collection, and these organizations are all germplasm collections. The remaining 87% partially duplicates their collections.

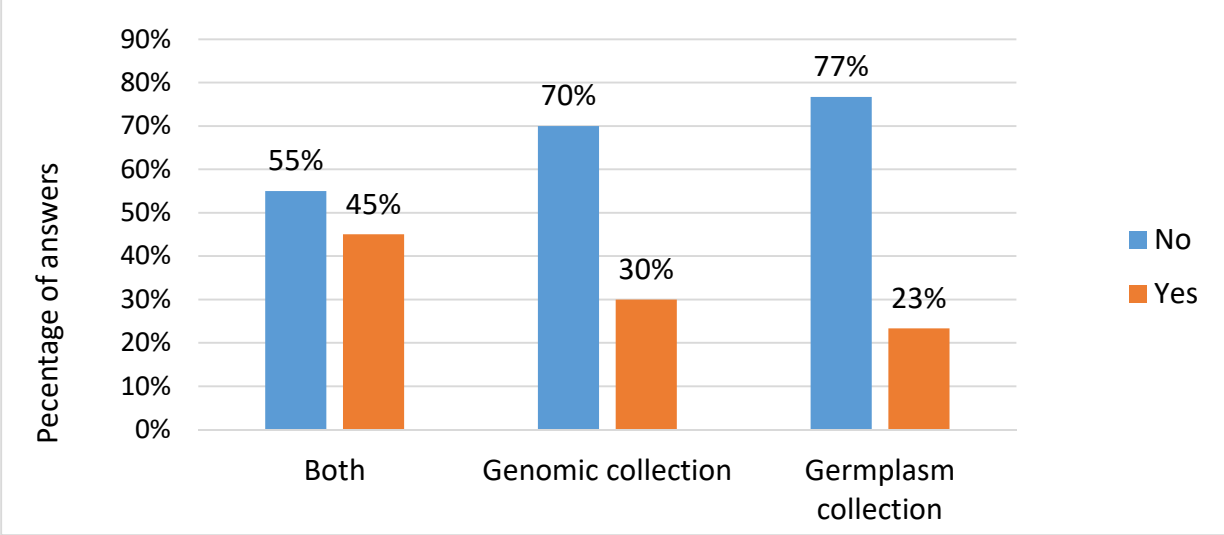
2.4. Involvement in a network

2.4.1. National Network of collections

QA: 97%	CR: 100%

At a country level, 25% of collections are involved in a national network of collections, 45% are not, whereas 30% of the countries have some of their collections connected to a national network. At collection level (Figure 6), when collections have genomic and germplasm collections, 45% of them are involved in a national network. This percentage drops to 30% for genomic collections only and 23% for germplasm collections only.

Figure 6 : Involvement in a national network at collection level



In several countries (Czech Republic, France and Italy), some collections are part of a national cryobank network for animal genetic resources where partners are sharing information (Czech Republic, France, Italy) or some of the samples are stored in a common place (France / individual nodes of the CRB Anim project). Currently in Spain there is not any formal network for cryoconservation animal genetic resources, however some banks are stored in a common place: the Spanish National Gene Bank (cf. http://www.mapama.gob.es/es/ganaderia/temas/zootecnia/razas-ganaderas/banco-nacional-germoplasma/)

Here are two examples of a national network:
- France: www.crb-anim.fr
- Italy: www.genrescryonet.unimi.it

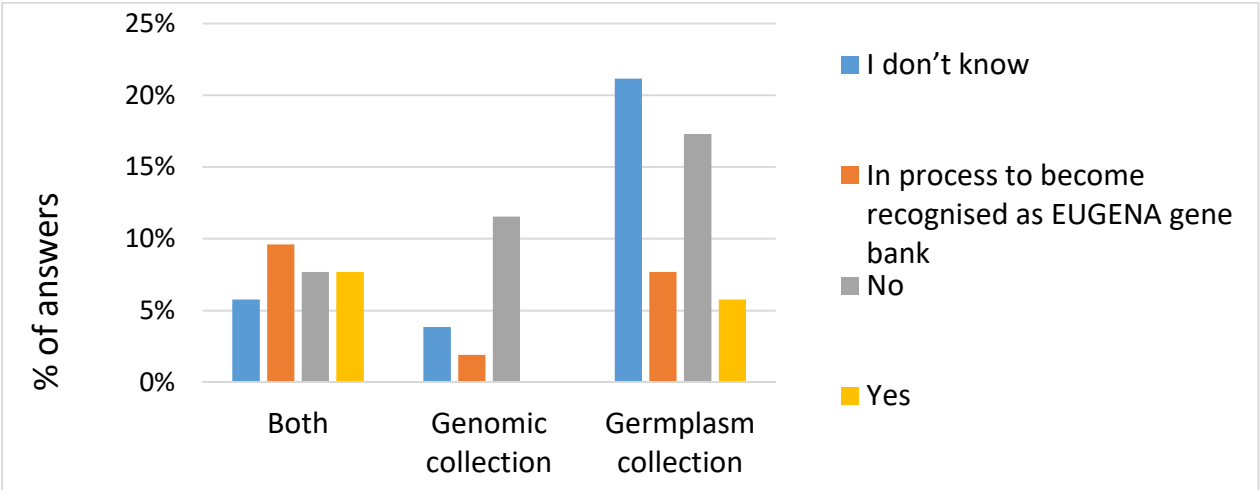
2.4.2. INVOLVEMENT IN THE EUGENA NETWORK

QA: 84%	CR: 90%

The European region, through its Regional Focal Point for Animal Genetic Resources, has established the European Genebank Network for AnGR (EUGENA). The EUGENA is a network of Member Genebanks in European countries with aim to support the ex situ conservation and sustainable use of AnGR and facilitate the implementation of the FAO's GPA and the Nagoya Protocol for ABS in Europe.
EUGENA is working on the basis of EUGENA Terms of Reference. EUGENA itself does not constitute a legal entity but operates by its Member Genebanks collectively. The Member Genebanks operate in accordance with their respective national rules.
(EUGENA Portal : https://eugena.comtechsys.biz/en/about/what-is-eugena)

The EUGENA terms of reference were finalized in 2014 which is fairly recent and may explain why a mere 13.5% of the genetic collections indicated that they are participating in the EUGENA network (Figure 7). A more encouraging 19% are in process to become recognized, however 67% of the genetic collections are not participating or do not have enough knowledge about the network. The IMAGE project should definitely help the promotion of the EUGENA initiative.

Figure 7 : Collections involvement in the EUGENA network



2.4.3. INTERNATIONAL NETWORK

QA: 90%	CR: 90%

Only 4 collections stated to be participating in an international network, two answers mentioning EUGENA, the rest being (several answers were possible) the International Sheep Genomic Consortium, the Adaptmap Consortium, the European Cattle Genetic Diversity Consortium, the Global Genome Biodiversity Network (GGBN), EFABIS and DAD-IS. This question was probably not well understood and could have been rephrased to have more answers.

3. MANAGEMENT OF THE COLLECTIONS

3.1. COLLECTIONS PURPOSES

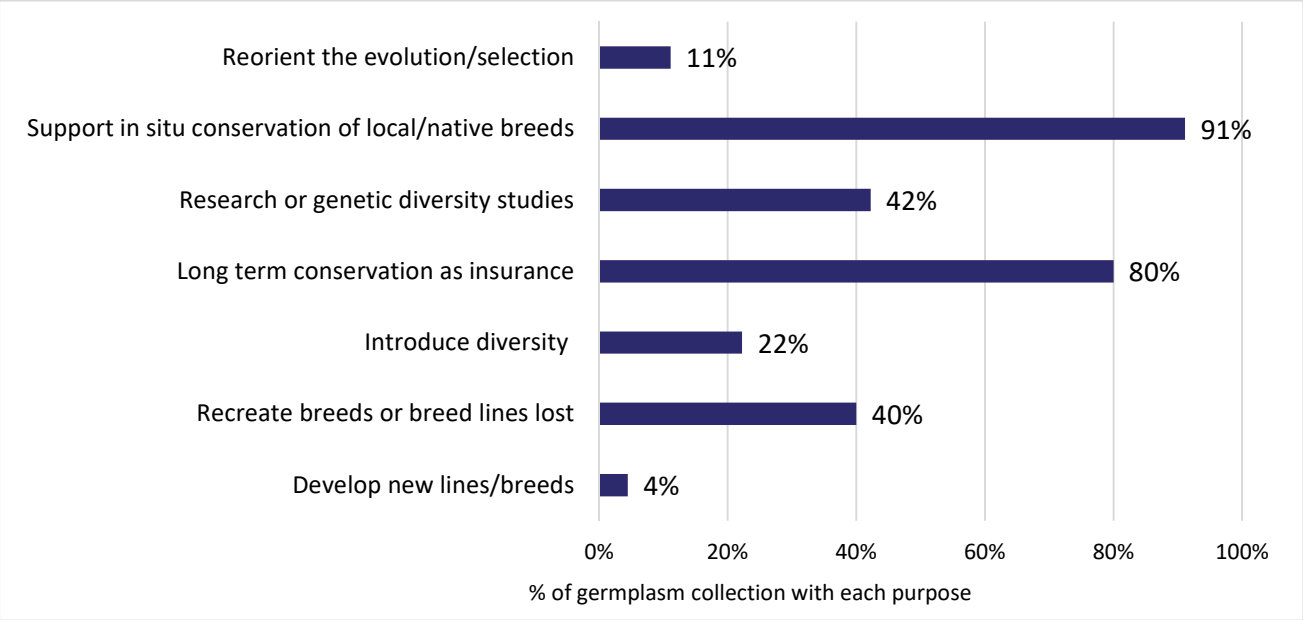
QA: 73%	CR: 80 %	Germplasm collections
QA: 73%	CR: 93%	Genomic collections

For a large majority of the germplasm collections (Figure 8), their main purposes to preserve genetic material are:

- Long-term conservation as insurance (80%)
- Support *in situ* conservation of local/native breeds (91%)

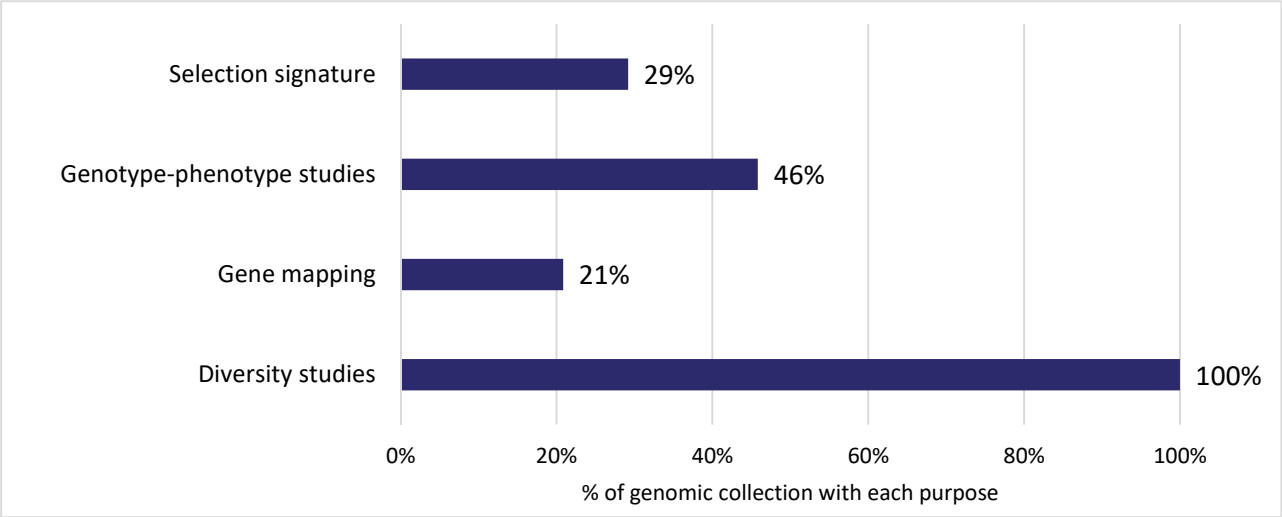
In some cases, the collections purposes are outweighed by the species and/or the status of breeds that is sampled (selection / conservation).

Figure 8 : Purposes of the germplasm collections



As for genomic collections, they all include diversity studies as one of their purposes (Figure 9). Other purposes might differ depending on the species mostly.

Figure 9 : Purposes of the genomic collections



3.2. COLLECTIONS SAMPLING

QA: 82%	CR: 89 %	Germplasm collections
QA: 87%	CR: 67%	Genomic collections

When answering (cf. quality indicators), most collections (90% of the germplasm and 70% of the genomic ones) have rules or guidelines to sample their donors.

For germplasm collections, the most common rules are:

- Sampling the highest genetic diversity within breed (rare breeds mostly);
- Collecting samples that are meeting the species sanitary requirements for AI collection;
- Sampling donors by their genetic values (main stream breeds).

For genomic collections, aliquots were sampled:

- By research project (i.e. sampling is decided by an organization that might be external to the collection);
- By collecting within breed diversity: sampling unrelated animals within a breed;
- By collecting between breeds diversity: collecting as many breeds as possible for a given species and in a given country / region;
- Sampling procedure could be decided for the germplasm collection, with a coupling done with a genomic collection.
- Sanitary aspects are also quoted; however, it is unsure which requirements are checked in this case.

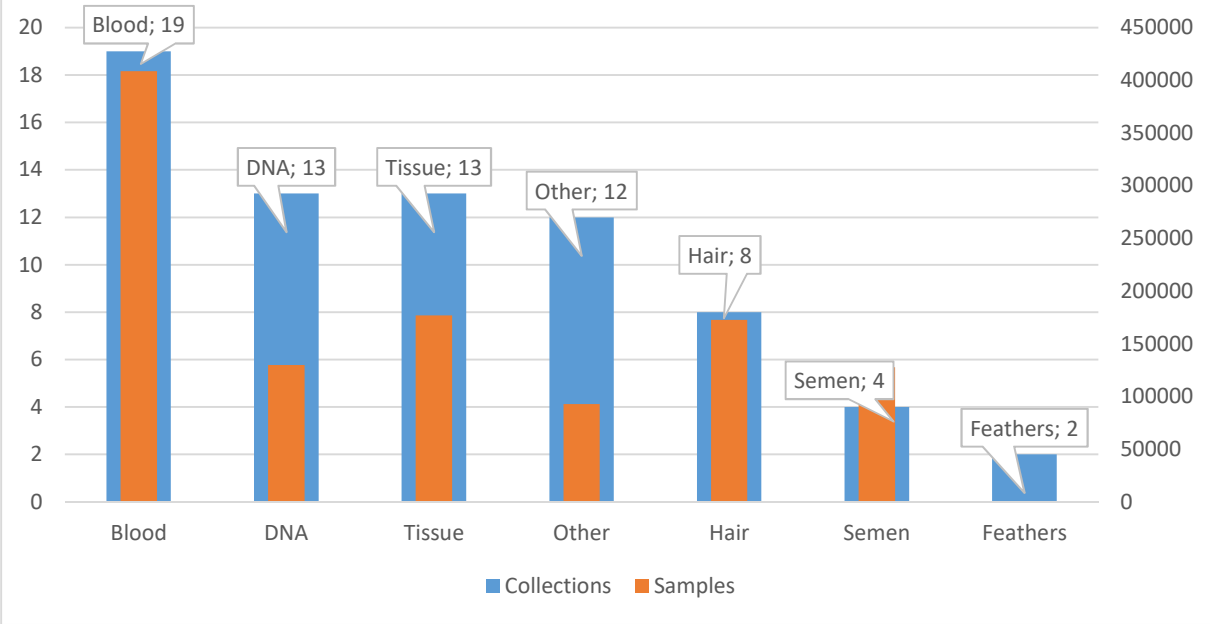
3.3. TYPE OF GENETIC MATERIAL

QA: 76%	CR: 83%	Germplasm collections
QA: 73%	CR:93%	Genomic collections

Germplasm collections are hosting mostly semen (97% of the collections), followed by embryos (51%), and then with a much lesser frequency somatic cells (10%), oocytes (8%) and ovarian tissues (3% = one collection only in Ukraine). When summing the number of doses per collection, 99% of the material consists of semen.

There is a much wider variety in the genomic collections as shown in Figure 10. It has to be said though that when "DNA" was stated, it is not always clear if specific DNA collections are set up or if it is DNA collections to be extracted from whatever tissue is actually kept in the collections. In the "other" category was grouped bees, case worms, embryo, embryonic fibroblast cell culture, feces, FTA card, microorganisms from the rumen, milk, PGC cell lines, saliva and wool. As for embryo, semen or PGC cell lines for instance, the information about how the samples are preserved is not stated, which means that we cannot say if these collections could be also considered as reproductive material ones or not. Blood is also the main material kept in the collections by the number of samples (Figure 10) while the tissue collection is actually more important than the DNA one.

Figure 10 : Main biological type kept in the genomic collections (left) and number of samples (right) by type of material



3.4. STORAGE COST

QA: 98%	CR: 100%

As seen previously most collections are hosted by public institutions, which means that they are (largely) publicly funded. Among the collections that answered, less than half (28 collections representing 14 different countries) have a good knowledge on what are the direct costs of keeping their collections.

In the long run, for sustainability of the collections, it is important for each organization to retrieve what are the exact costs related to development and hosting their collections. This is also essential for better fund planning as well as for the implementation of a fee policy if/when needed.

With this in mind, another specific task of the IMAGE project is to perform an economic analysis of genetic collections, and more specifically a cost/benefit analysis of gene bank investments, using different future scenarios. This economic analysis will make us of data provided by organizations that have such data and are willing to share them (23 organizations responding to the survey) plus 12 more organizations that said that they are not collecting these data nowadays but have the ability to collect such information.

3.5. FEE POLICY

QA: 97%	CR: 100%

Only 15 organizations have implemented a fee policy, whatever the collection type (genomic or reproductive). As we saw in the previous paragraph, a plausible explanation might be that collections are mostly managed by public bodies and there is limited use of collections.

For the organizations with a fee policy, we have little details on how fees were implemented. For reproductive material, what is the most common, organizations implemented a fee per AI dose. In some cases, the dose is free of charge for the breeders in case of rare breeds. Other arrangements found are a global fee for the sample storage of the whole breed collection.
Only one answer was given for genomic collections, the @Bridge collection (INRA, France), where different fees are applied depending on who the user is: team users (fee for consumable and storage costs), INRA users (added costs: energy), other public users (added costs: maintenance) and private users (added costs: manpower, which corresponds to total full cost).

3.6. QUALITY MANAGEMENT SYSTEM

QA: 97%	CR: 100%

In comparison to the collection of cost there were more organizations that were saying to have implemented a quality management system (28 collections; 14 different countries). Another specific task of the IMAGE project should give more insights on what are the quality management procedure and protocols implemented.

For these three previous questions (cost, fee, quality), Table 3 recapitulates the answers per country.

Table 3 : Cost knowledge, quality management system (QMS) and fee implementation per country

COUNTRY	COST			QMS			FEE POLICY		
	N/A	No	Yes	N/A	No	Yes	N/A	No	Yes
AUSTRIA			1			1			1
BELGIUM		1			1			1	
CROATIA		1			1			1	
CZECHREPUBLIC	1		1		1	1		1	1
FRANCE		1	3		2	2		3	1
GERMANY		1	3		4			3	1
HUNGARY		1	1		1	1		2	
ICELAND		1			1			1	
ITALY		1	2		1	2		3	
LATVIA			2			2		2	
MONTENEGRO		1				1		1	
NETHERLANDS		1	1		1	1		1	1
POLAND			1			1			1
PORTUGAL			1		1			1	
ROMANIA			1		1		1		
SLOVENIA		1				1		1	
SPAIN	1	9	19	1	16	12	1	22	6
SWEDEN		1				1			1
UK		1	1		1	1		1	1
UKRAINE			1			1			1
TOTAL	**2**	**21**	**38**	**1**	**32**	**28**	**2**	**44**	**15**

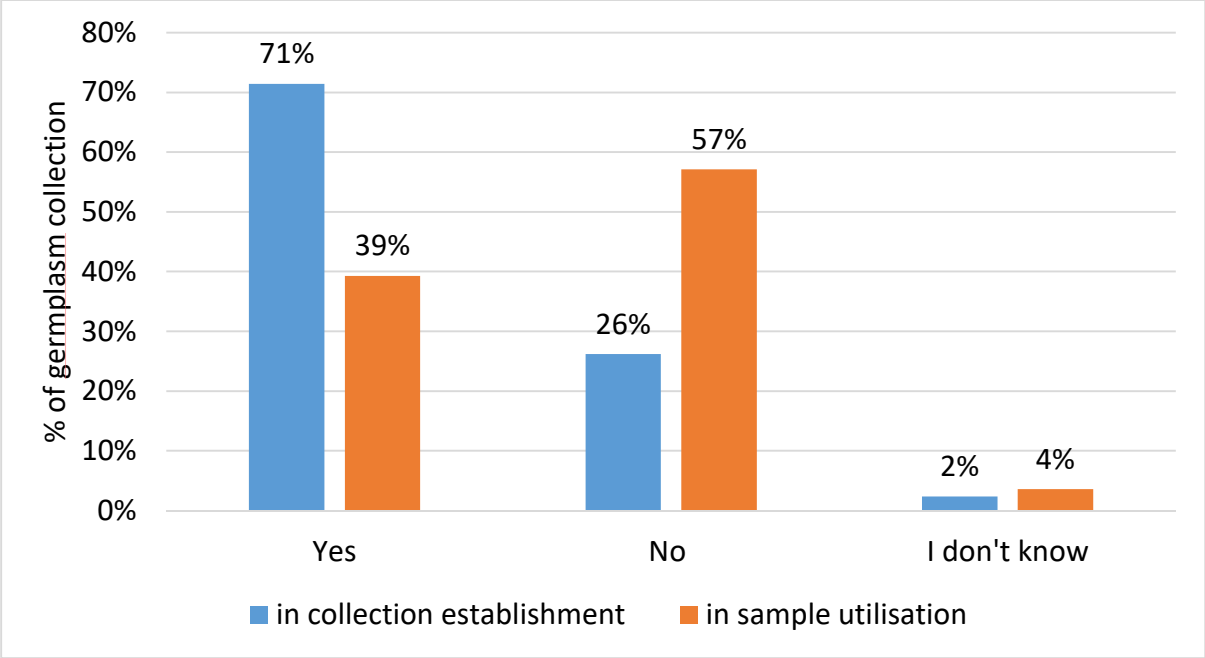
3.7. SANITARY REQUIREMENTS – GERMPLASM COLLECTIONS ONLY

3.7.1. NATIONAL REQUIREMENTS

QA: 82%	CR: 89%	Sanitary rules / collect
QA: 71%	CR: 78%	Sanitary rules / use

When there was an answer (cf. QA), 71 % of the organizations that are hosting a germplasm collection said that there are sanitary requirements in the national law for collecting samples. As far as sample use, only 39% of the collections are reporting the existence of sanitary requirements for sample utilization (cf. Figure 11). AI regulations in livestock provides the legal framework for collecting and using frozen material. Therefore, the discrepancy that we see between the answers seemed surprising. One of the explanations, as we will see later, could be that some countries consider that using material from a genebank is different than using material coming from AI centers.

Figure 11 : Existence of sanitary requirement in the national law



The development of cryoconservation is mostly related to the use of Artificial Insemination in livestock species. Sanitary rules were set up for selling and exchange of semen. In most cases germplasm collections are a diverticula of AI activities, which means some species are under sanitary regulations for collection and utilization such as ruminants, pig and horses. It is actually quite surprising that some organizations answered that such requirements do not exist; further investigations are needed to make sure that the question was well understood.

For collecting material, in most countries the national regulations follow the EU regulations for all the controlled species, which means only approved AI stations are permitted to collect and to distribute semen. In some countries derogation for local breeds allows germplasm collection on farm (Italy, the Netherlands, and Spain in some cases). For the Czech Republic, there is a derogation in sheep and goat for on farm collection, however the males need to meet the standard sanitary requirements for AI centers and doses cannot be used in standard production environment. As mentioned by Spain if

genetic material of a breed is collected without following the EU regulations, the samples are stored separately and documented.

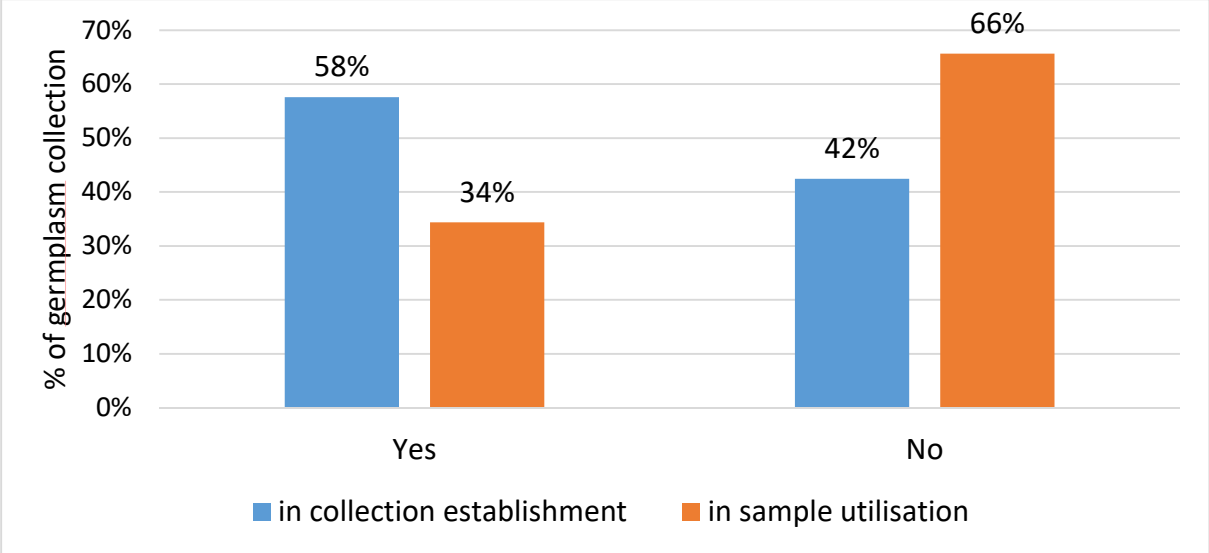
Since most genetic material is produced and stored according to EU Regulations, most of the time there are no further specific requirements for using it. In the few cases where the regulations could not be followed, several options are set up:

- In the Czech Republic, when material was collected prior the EU regulations, samples cannot be used before checking, if there is documentation on how it was collected and if it meets the new requirements.
- In France (Guadeloupe), there are derogations for local use.
- In Spain, there are exceptions to the sanitary rules for using genetic material from germplasm banks. The material under this exception needs to be specifically authorized to be used and only under certain circumstances.
- In the Netherlands there is a specific derogation for local cattle breeds, of which specific requirements cover both collection and use.

3.7.1. SANITARY BOTTLENECKS

According to respondents, sanitary requirements are often blocking the collection (58%) and use of material (42%) (cf. Figure 12).

Figure 12 : Bottleneck regarding sanitary requirements



From a quality management point of view, all centers have to follow the national regulations for storing genetic material. However, when organizations follow this requirement, it appears to be extremely challenging to acquire, process, store and distribute different type of reproductive material from different species, which can even lead to destroying stocks and threaten the survival of breeds.

From the comments we had, it seems that it is mostly in rare or local breeds that the collection and/or use is difficult because it is harder for these breeds to comply with sanitary/veterinary regulations. Several organizations are pointing out that the sanitary/veterinary regulations, which have been developed for the commercial livestock sector and for export/import, are too restrictive for

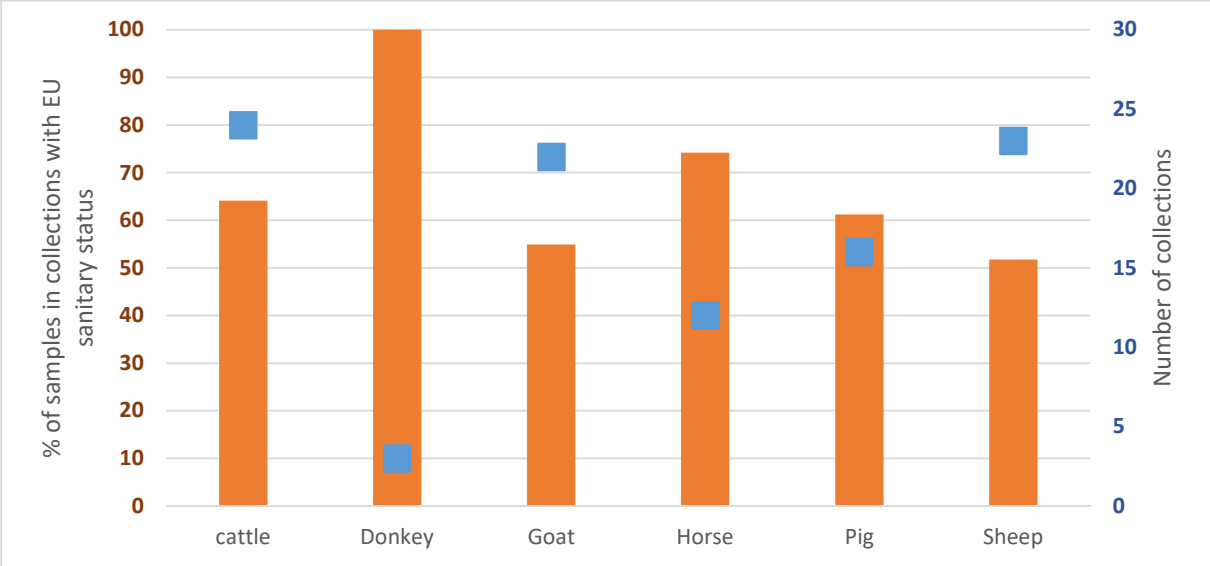
conservation purposes, and that local breeds herds rarely fulfill sanitary requirements for entering in an EU certified AI center. Other issues are the regulations toward tropical diseases in territories that are not European (such as Guadeloupe) or sanitary status of old material which is often extremely valuable from a genetic variability point of view.

3.7.2. EU SANITARY STATUS

QA: 69%	CR: 83%

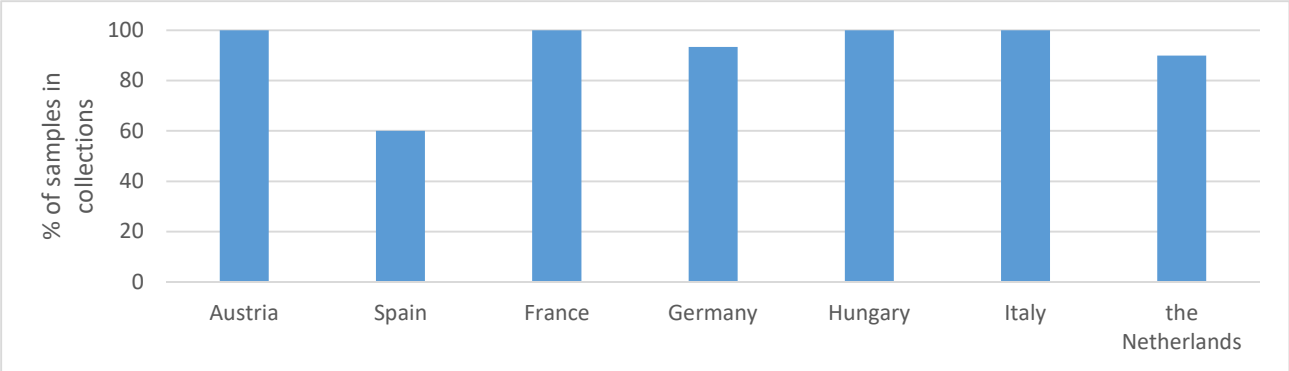
We saw in the previous paragraph (3.7.1) that in most cases the national requirements are following the EU sanitary requirements for the species that have such regulations (cattle, donkey, goat, horse, pig and sheep). This aspect of the survey was focused on how well the EU sanitary requirements were followed by different species. As shown in Figure 13, there is a clear disparity between species. The only species where all the collections are following the EU sanitary regulation is the donkey, but it is also the species with the smallest number of collections reported (2). It was also stated that the fact the absence of any recommendations on the sanitary requirements of *in vitro* conservation of poultry germplasm in the Council Directive 92/65/EEC is also prejudicial.

Figure 13 : Percentage of samples in collections with EU sanitary status and number of collections concerned by species



Within species, the samples do not have always the same status following the sanitary regulations as we illustrated with the cattle example (Figure 14). Nevertheless, samples which do not follow EU sanitary regulations are traced and correspond to derogations provided by national sanitary authorities.

Figure 14 : Percentage of samples in a country's collections that are following EU sanitary regulations: ***cattle***

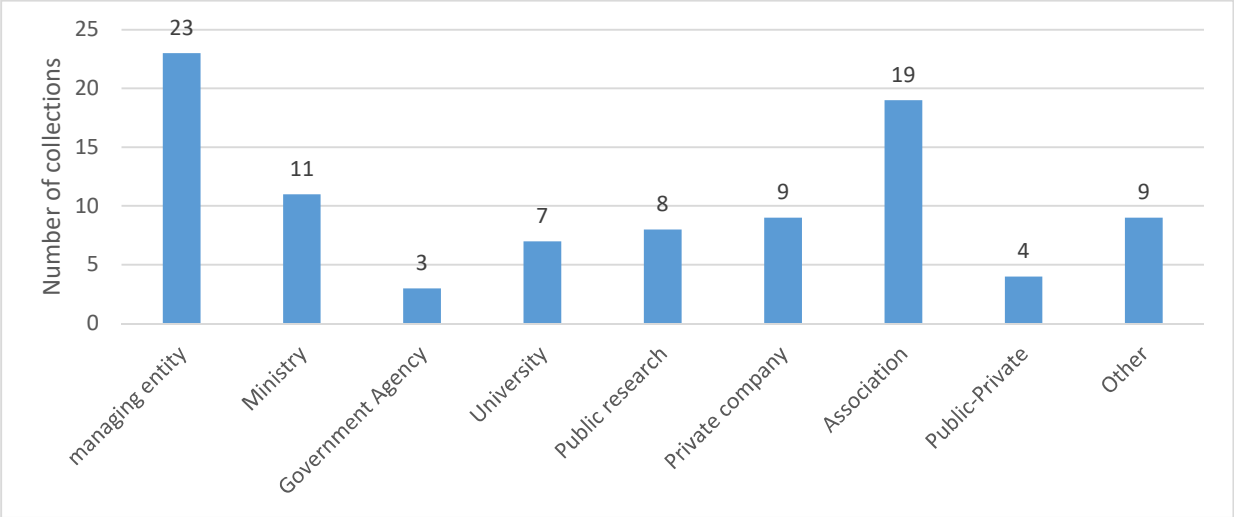


3.8. OWNERSHIP, CONTRACTS AND ACCESS TO MATERIAL

3.8.1. OWNERSHIP RIGHTS OF THE MATERIAL

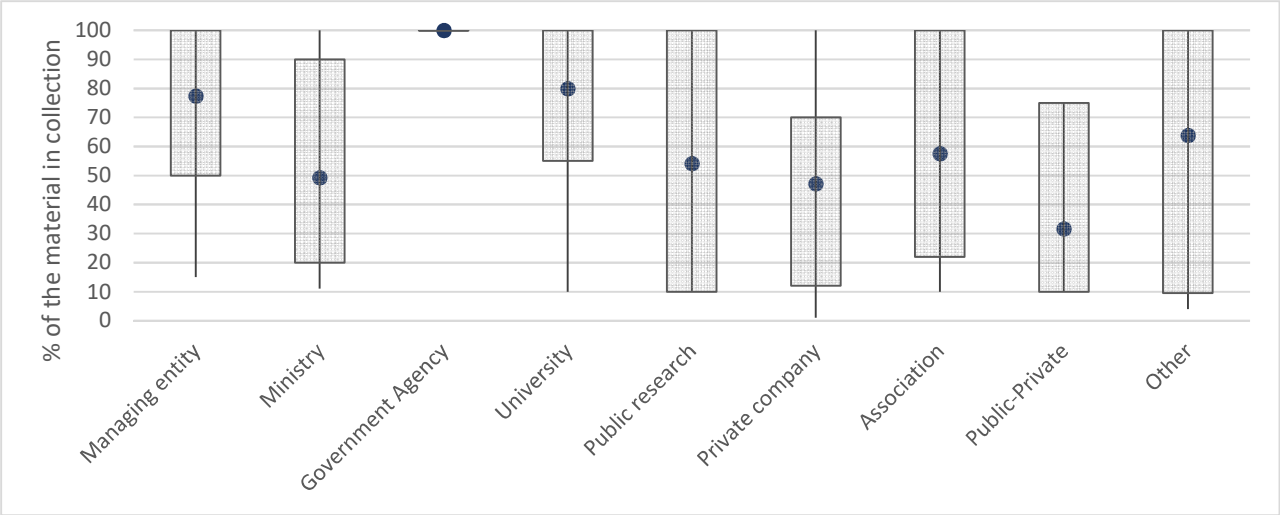
Most collections (Figure 15) were declared as being owned by the "managing entity" (23 collections), followed by associations (19) and Ministries (11). However, one Ministry declared its collection to be owned by the "managing entity" as well as 7 Universities and 11 public research institutions. In the end it seems that most collections belong to a public institution.

Figure 15 : Categories of owners



However when looking more into details it seems that some institutions claimed to own the entire collection while it actually owned only part of the collection as shown by their answers to the following question. Genetic collections are owned by only one type of institution for 61% of them, 27% by two different types of institutions and 12% by three or more different types of institutions. This percentage varies depending on the type of institution that is managing the collection (Figure 16), a tendency being that when a public institution is in charge, it owns most of the collection.

Figure 16 : Percentage of material in collection owned by each category of owner

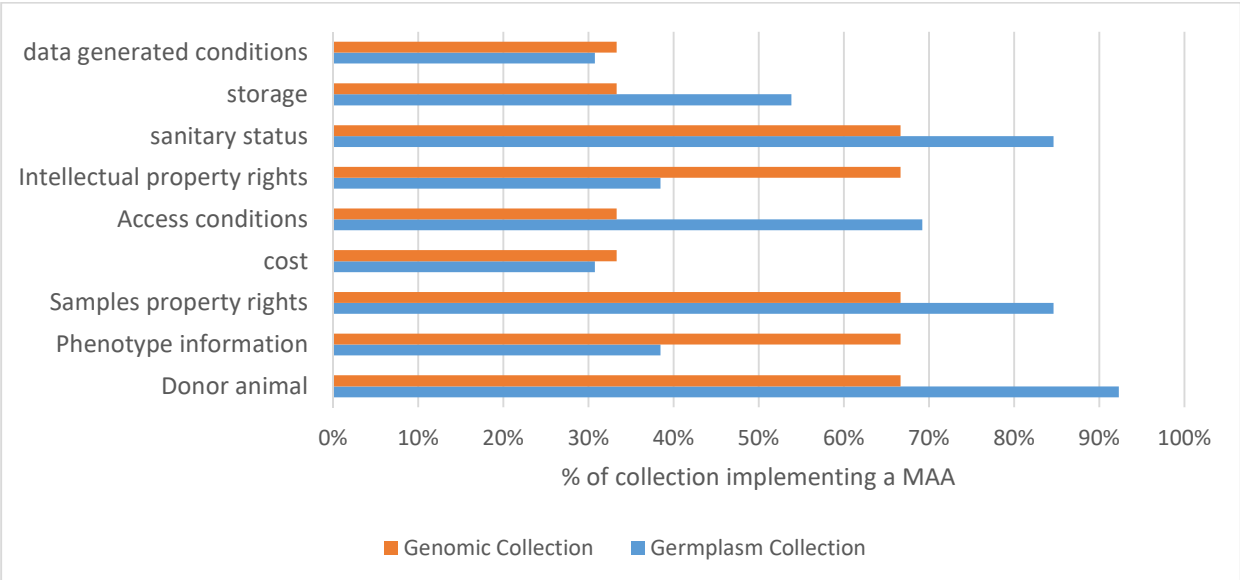


3.8.2. MATERIAL ACQUISITION AGREEMENTS - MAA

QA: 25%	CR: 44%	Germplasm collections
QA: 80%	CR:93%	Genomic collections

We defined as "MAA" any kind of formal agreement or contract that exist to regulate the acquisition of material for the collection. Very little information was provided for this question in the case of the germplasm collections since only 25% of the organizations answered the question. It does not mean that such agreements do not exist, however they are probably not in common use if the question was not well understood by the collections' managers. Among the few answers we received for germplasm collections, some details were given showing that in several cases it might not be acquisition *per se* which is regulated but more specifications are given on how the samples can be used.
Among the type of information included in a MAA agreement (Figure 17), the most common ones for germplasm collections are information about the donor, samples property rights, sanitary status followed by access conditions. For genomic collections, five conditions were quoted at an equivalent frequency: donor, phenotype information, intellectual property rights and sanitary status.

Figure 17 : Type of information included in a MAA agreement



3.8.3. ACCESS AND USE OF THE COLLECTIONS

QA: 88%	CR: 89%	Germplasm collections
QA: 80%	CR:93%	Genomic collections

Only 11% of the germplasm collections are available without conditions (Table 4). These collections are set aside, the others are available depending on the user (80%) and/or the provider (65%) and/or only part of the collection is available (55%). One organization answered "no" to all the questions because they have not worked on who can use the collection yet. Several organizations mentioned that a very limited number of samples were stored, therefore their access was limited either to the breed's association and/or the organization in charge of the collection. The use would have to be exceptional or in the case of emergency situations. Most collections mentioned that samples were kept for long term conservation.

Table 4 : Availability for use of the different collections

	Germplasm collections	*Genomic collections*
Use is not restricted	11%	8%
Depends on the user	80%	64%
Depends on the provider	65%	27%
Part of the collection only	55%	27%

The following use purposes were mentioned for accessing the germplasm collection:

- Conservation / recovery of a breed;
- Introduce genetic variability in a breed;
- Research projects.

Also, in some cases the sample users have to meet further requirements, such as:

- Re-put material in collection;
- Use the material in pure breed only;
- He needs the consent of the owner / breed association (which relates to MTA as we will see in the following paragraph).

As for genomic collections, only 8% were available without conditions. In most cases the answers were quite exclusive (as an example the material can be used depending on the original provider only), which is not the case for the germplasm collections. Two collections stated no possibility of use, the reason being that the conditions for using the material were not defined yet.

Most of the uses mentioned for accessing a genomic collection were linked to the research project for which the collections were set up, for example in diversity studies. Other requirements were also mentioned such as:

- Technical feasibility;
- Absence of conflict of interest;
- Economic relevance/ benefits of the project;
- Traceability / Legal use / Mention of the collection in a future publication.

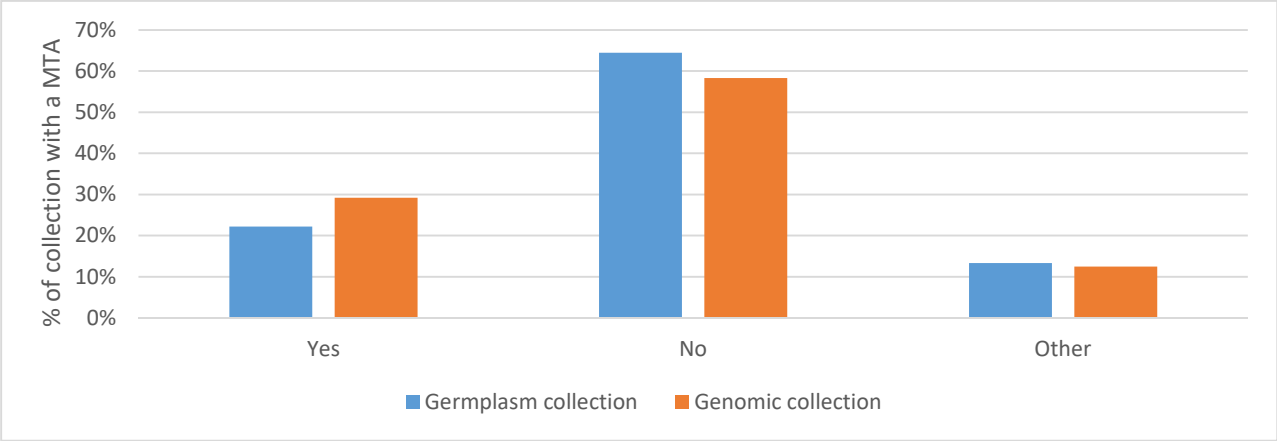
3.8.4. MATERIAL TRANSFER AGREEMENTS (MTA)

QA: 88%	CR: 89%	Germplasm collections
QA: 80%	CR:93%	Genomic collections

In this part we asked if Material Transfer Agreements (MTA) were in use for distributing germplasm material from the germplasm collection to users. As shown in Figure 18, a fairly small proportion of organizations are using such a document or equivalent ("other"). One of the reasons is probably that

most collections are still under-utilized as we will see in the next paragraph (3.9). Most organizations are still in the phase of building their collections.

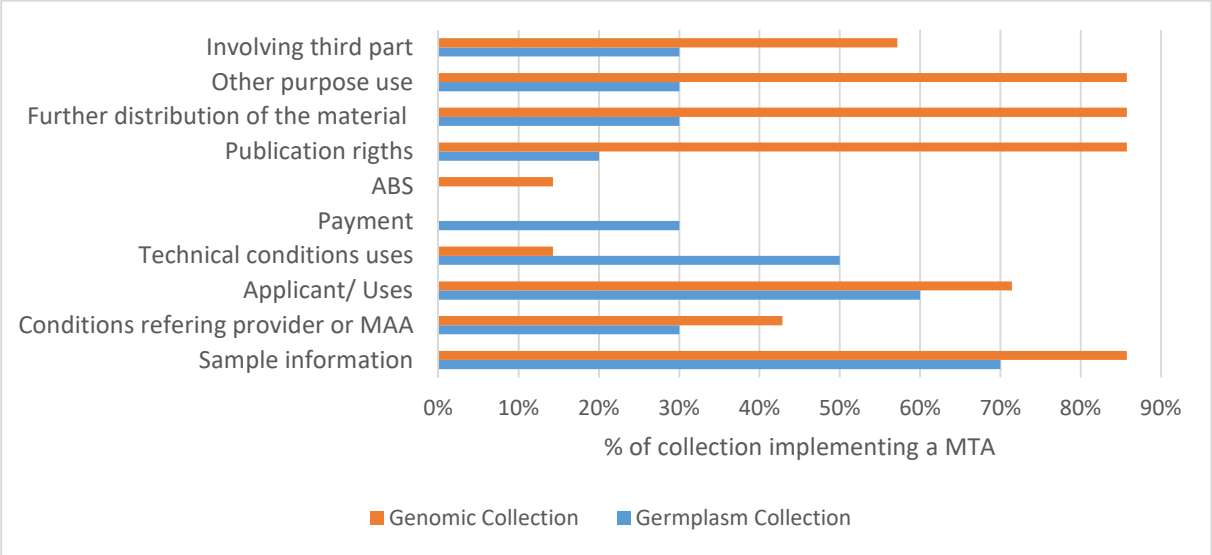
Figure 18 : Implementation of a MTA by collection type



The Nagoya protocol on Access and Benefit Sharing and its implication are quite poorly known in the AnGR and research community. It is confirmed by the mere 14% of the germplasm collections and 1% of the genomic collections that have set up a specific paragraph about obligations for users arising from national ABS (Access and Benefit Sharing) legislation, which can be explained by the fact that most of the European countries have not implemented national access legislation for genetic resources. In the case of germplasm collections, MTAs seems to be fairly similar from one collection to another (Figure 19), with clauses that include sample information, publications rights, details on the rights to distribute the material further, as well as rights to use for other purposes. All these conditions are included in 86% of the MTAs implemented.

On the other hand, there is much wider variety of MTAs for genomic collections, for example mentioning a payment for sample/processing of the sample which is never quoted for germplasm collections (cf. paragraph on Fee policy). Among the requirements, it was also stated that in some cases the distribution of samples for research purposes should contribute to the collections knowledge, therefore the data acquired through the collection use should become available for the gene bank.

Figure 19 : Clauses included in the MTA



In the end, it is interesting to see that MTAs or equivalent were actually more common (in percentage) for genomic collections than for germplasm collections. The difference is probably due to the fact that

genomic collections were far more project oriented (the material sampling and storage is designed with an expected use in mind) than the germplasm ones (material is stored mainly for long term conservation purposes). Moreover, exchange of samples between universities/institutes and countries is common in scientific research projects and genomic collections.

3.9. Samples Flow – Germplasm collections

QA: 71%	CR: 83%

In most countries (Table 5), storing new material is project dependent, which means that the numbers given were usually an average calculated over a time period. The majority of our answers showed that specific efforts are made to collect as many donors as possible for rare breeds, in a given species. Regular entrances are done only for breeds with progeny testing programs and/or where AI use is common, which means mostly for dairy cattle, and sometimes for sheep.

Table 5 : Average number of new donor animals, for which samples have been acquired every year, per country and species

COUNTRY	CATTLE	EQUIDS	FISH-SHELLFISH	GOAT	PIG	POULTRY	SHEEP	OTHER	TOTAL
AUSTRIA	110	0		9	1		6		126
BELGIUM		0					0		0
CZECH REP.	5	4	40	2	3		2		56
FRANCE	62	11	25	5	25	105	50	72	283
GERMANY	30	0			0	160	40		230
HUNGARY						67		30	67
ICELAND	25			3			20		48
ITALY	1			7	8		3		19
NLD	200	10		5	20	32	10	6	277
POLAND	6						0		6
SLOVENIA	5								5
SPAIN	716	75		225	135	50	312	79	1513
SWEDEN	8	3		0	10		0		21
UK							10		10
UKRAINE	0		0	0	0	0	0	0	0
TOTAL	1168	103	65	256	202	414	453	187	2660

As for use, Table 6 shows that most collections are still in the process of storing material with little or no material going out of the collections: several collections are quite recent such as the Belgian or the German ones. One of the reason of the little use is that frozen AI is seldom used in some species (or countries) such as pig, sheep or poultry. Therefore, the collection is kept to be used in case of emergency only (such as after a major disease outbreak that would have wiped out part of a breed). For cattle and goat in Spain, as shown by the large number of material going out per year from the collections, there is a commercial use of the semen, nevertheless some centers also have a collection for long term conservation and sustainable use of the breed following EUGENA definition. For the other species/countries, use is related to research projects (France, Iceland, The Netherlands, Spain). Samples are also taken to check their sanitary status or viability. In few cases, there is a use for breeding purposes to support *in situ* conservation of local native breeds, usually in cattle (Austria, the Netherlands) but there are exceptions (sheep in France), and the number can vary greatly depending on the years.

Table 6 : Average number of samples taken out by species and country / year

COUNTRY	AQUATIC	CATTLE	GOAT	HORSE	PIG	POULTRY	SHEEP	OTHER	TOTAL
AUSTRIA		30	50		2		0		**82**
BELGIUM				0			0		**0**
CZECH REP.	800	6 500		200	1000				**8 500**
FRANCE	0	50	0	5	70	0	20	25	**170**
GERMANY		100					0		**100**
HUNGARY						461		25	**486**
ICELAND		0	50				0		**50**
ITALY		30	0		0		0		**30**
NETHERLANDS		150		5	2	5	0	0	**162**
POLAND		100					0		**100**
SLOVENIA									**0**
SPAIN		208 540	12 418	233	80	60	505	90	**221 926**
SWEDEN			0	0	0		0		**0**
UNITED KINGDOM							0		**0**
UKRAINE	0	5	0	0	0	0	0	0	**5**
TOTAL	800	215 505	12 518	443	1154	526	525	140	**231 611**

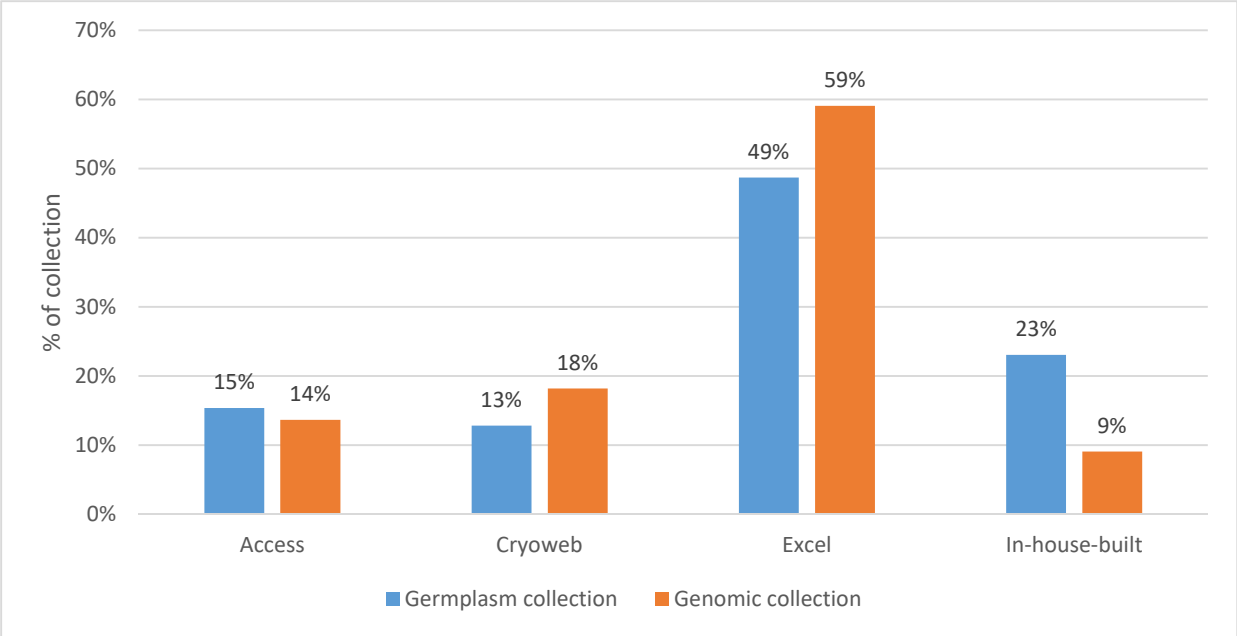
3.10. DATABASE

QA: 84%	CR: 80 %	Germplasm collections
QA: 73%	CR: 93%	Genomic collections

3.10.1. DATABASE TYPES

95% of germplasm collections and all the genomic collections are implementing a database. However, as shown in Figure 20, very simple solutions are chosen in most cases since 73% of the genomic collections and 64% of the reproductive collections are just using Microsoft Office software. The “in house built” database are quite disparate. It goes from a simple sheet of paper coupled with Excel to a database application totally built in SQL language. The use of Cryoweb, which is an interface linked with a database specifically built for gene banks in Europe is mentioned by 13% of the germplasm collection and 18% of the genomic collections.

Figure 20 : Type of database implemented by collection

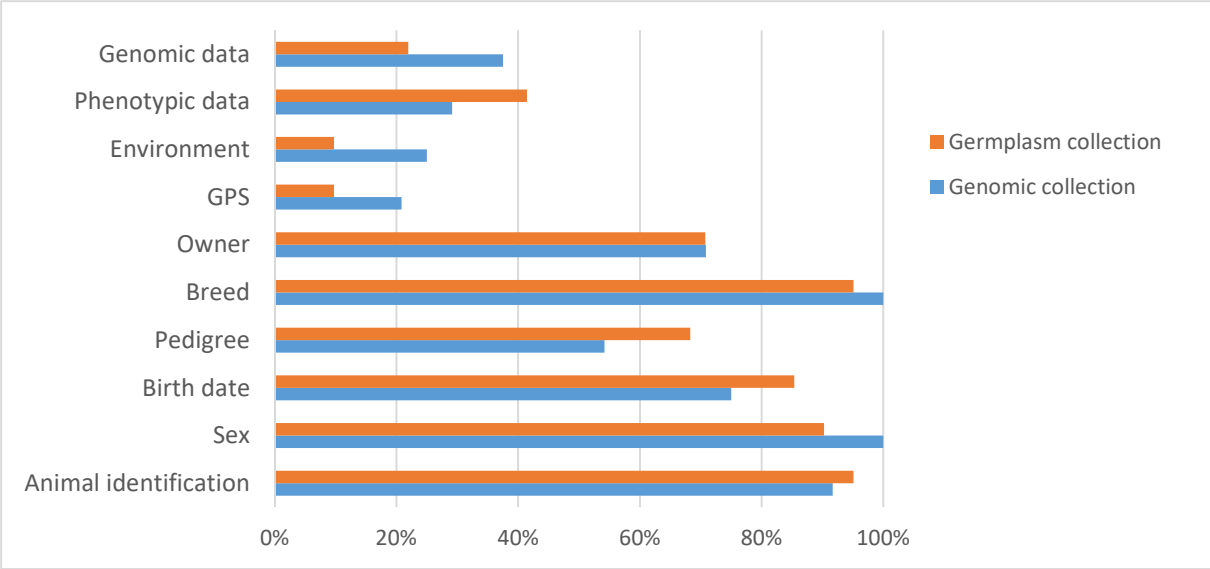


As far as the collections information on the Internet, we have a fairly blurry picture since only 60 % of the germplasm collections and 34% of the genomic collections have answered the questions. In the end, among the ones that answered, only 6 collections (2 germplasm and 4 genomic) provide information on a portal.

3.10.2. DONORS INFORMATION

For genomic collections, the only information which is always recorded is the breed and the sex of the donor. The donor identification is not always recorded in either case (germplasm or genomic). One of the reasons might be that in some species individual recording is not always mandatory. Environment and GPS data are among the least recorded data, but there is more effort for genomic collections. As we will see in chapter 4.2.2, genomic collections are sometimes harboring breeds which are not European, and in this case more data are collected to describe the breed (including GPS data).

Figure 21 : Type of information on the donor animals provided by the databases



Focus: genomic information in the genetic collections databases

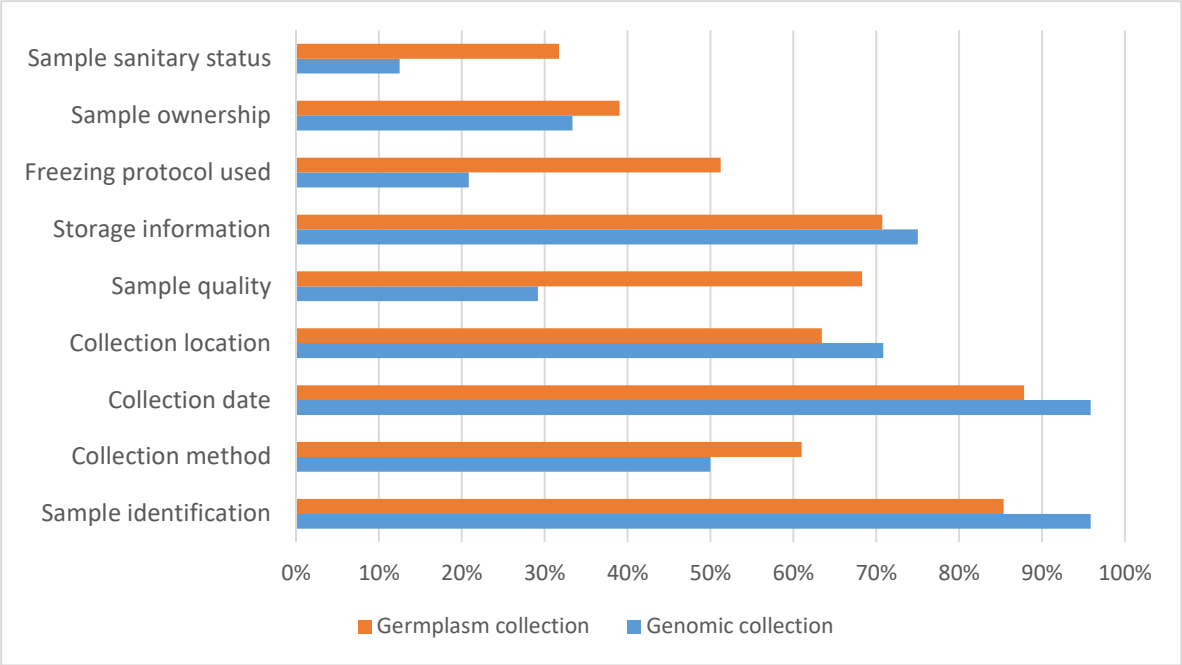
Genomic data are available for 22% of the germplasm collections. However, the type of information kept varies greatly, it goes from sequence analysis, SNP or microsatellite data to simple samples of DNA stored with the germplasm collections. Genomic collections are more consistent in gathering genomic information for obvious reasons (38% of the collections that answered) and microsatellites data are the most common (5 answers). The array of information depends also with in the collection, for instance it can go from microsatellite, AFLP, SNP, whole-genome sequence, exome sequence to mtDNA sequence data.

3.10.3. INFORMATION RELATED TO SAMPLES

The most commonly available information, whatever the collection types, is sample identification, collection date and storage information (Figure 22). We observe a large difference in the percentage of availability of information between the germplasm collections and the genomic collections for the following criteria: freezing protocol used, sample quality and sample sanitary status. For all those criteria, genomic collections have a much higher percentage of information available.

Other information available in the database are:
- Pictures;
- Name of the research project;
- Contact information;
- Type of biological material;
- Preservation method;
- Quality indicators such as sperm quality.

Figure 22 : Type of information on the samples provided by the databases



3.10.4. EMBL-EBI'S DATABASE – GENOMIC COLLECTIONS ONLY

QA: 67%	CR: 87 %

The questionnaire had a specific question to know if the genomic collections had their data recorded in EMBL-EBI's database (European Molecular Biology Laboratory - European Bioinformatics Institute). Only one collection answered yes (@Bridge, France), 16 answered no and 3 organizations did not know if they were recorded.

Overall there is a great need for a better documentation of the collections: the goal would be to access Biological Resource Center (BRC) standards, which start by documenting all samples with an appropriate database, and lot of the collections do not fulfill this simple requirement.

4. WHAT CAN BE FOUND IN COLLECTIONS?

4.1. SPECIES REPRESENTATION

A first snapshot shows that genomic collections are hosting a wider array of species with a total of 23 species versus 17 for the germplasm collections (cf. Figure 23 and Figure 24), keeping in mind that this greater variability might be even bigger in genomic collections since we have less answers for this question than for germplasm ones'. It is much easier and less costly to get samples (blood or skin tissue) for genomic collections, which explains why there is such a variety in comparison with germplasm collections.

Table 7 : Number of answers by type of species

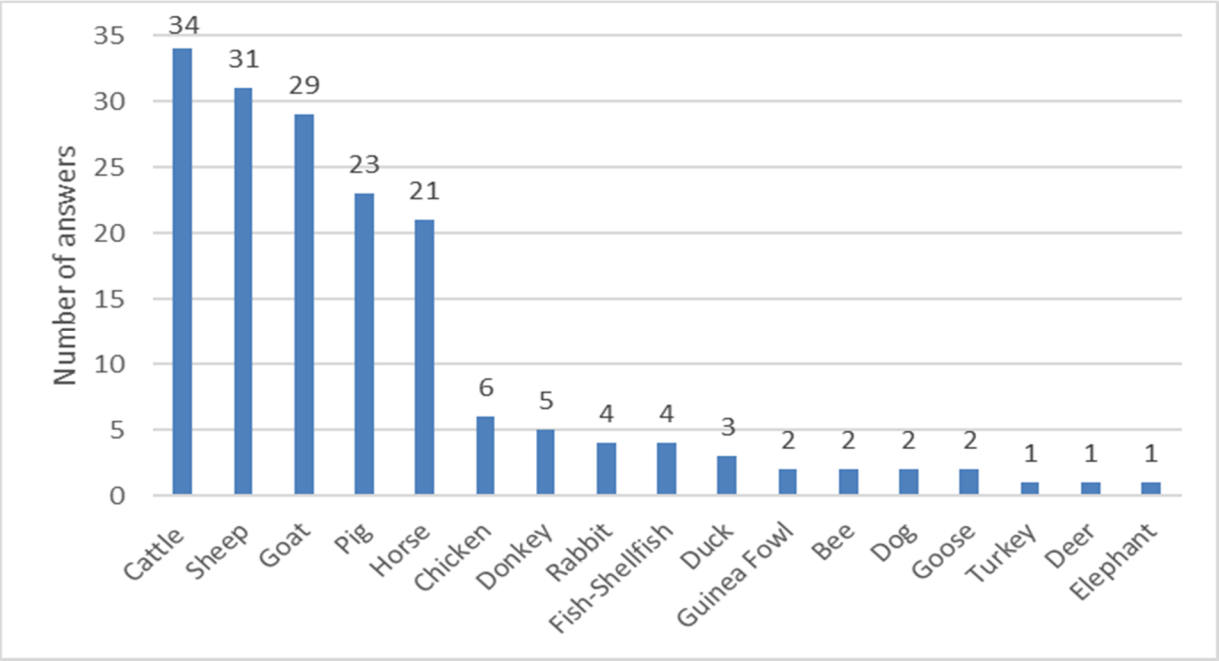
	Germplasm	Genomic
Livestock (mammals)	**147**	**76**
Poultry[1]	14	23
Water species[2]	4	3
Insect species[3]	2	3
Game species[4]	1	2
Dog	1	1
Wild species[5]	1	2
Fur species (mink)	1	1
Guinea Pig	0	1
Total	**147**	**76**

[1] *Chicken, guinea fowl, goose, turkey, duck and quail*
[2] *Fish and shell fish, no other specifications*
[3] *Bee and silk worm*
[4] *Deer and pheasant*
[5] *Elephants, camel and free-living animal*

The five most common species in the European germplasm collections are cattle, sheep and goat, pig and horse. The other species are much less common, and they include one wild species (Elephant) and dogs for two collections. As for deer, it cannot be guessed if the samples were taken from raised animals or wild livestock. The species representation follows how easy it is to collect samples, balanced by their economic importance in agriculture. For instance, pig or chicken are of greater economic importance than sheep or goat but semen cryoconservation is not common in these species. Also, most lines are owned by private companies and they might be more reluctant to be part of a collection than in ruminant species where breeds are still in charge of breeders' association.

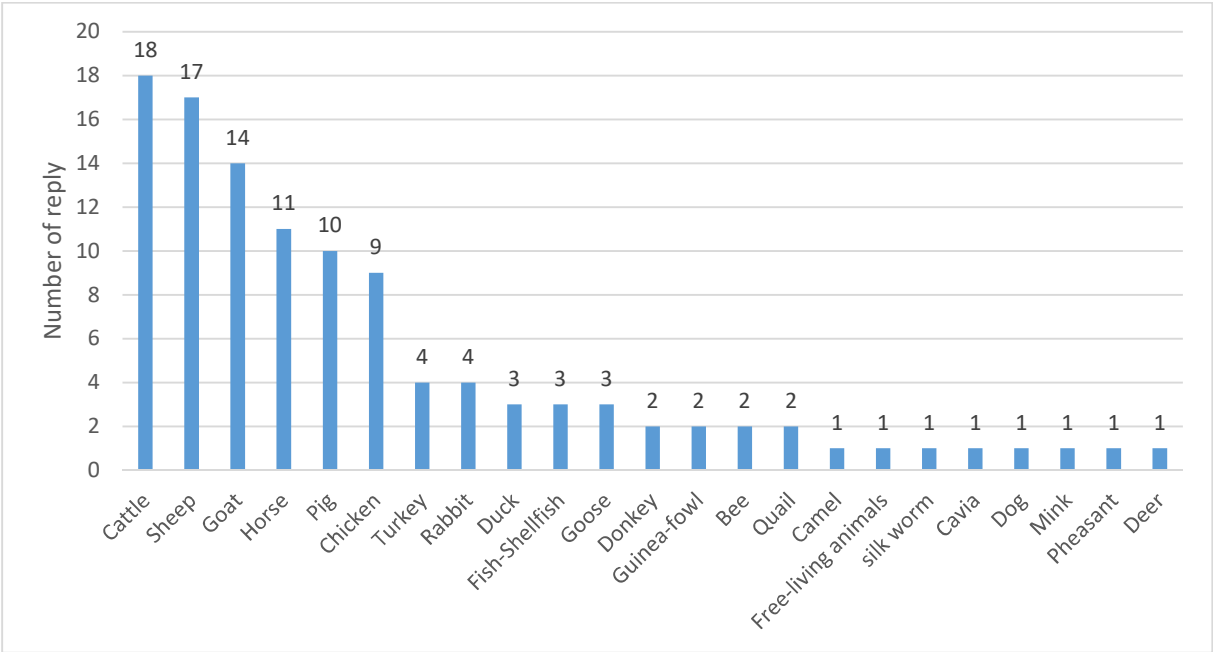
It is interesting to see that most countries in Europe are comprehending the same way what species should be included in the collections: there are almost no wild species, the main collections being probably under the umbrella of zoos or museum of natural history, and dogs are seldom present. This species is probably kept by specific collections devoted to pets.

Figure 23 : Number of genetic collections per species



Despite a bigger species diversity in genomic collections, the most common species are the same as for germplasm collection, with Horse and Pig which are inverted.

Figure 24 : Number of genomic collections per species



However, it appears that this first snapshot is indeed biased as we will see in the paragraph 4.2. When asked for specific details of their collections, the organizations that answered gave a much wider panel of species.

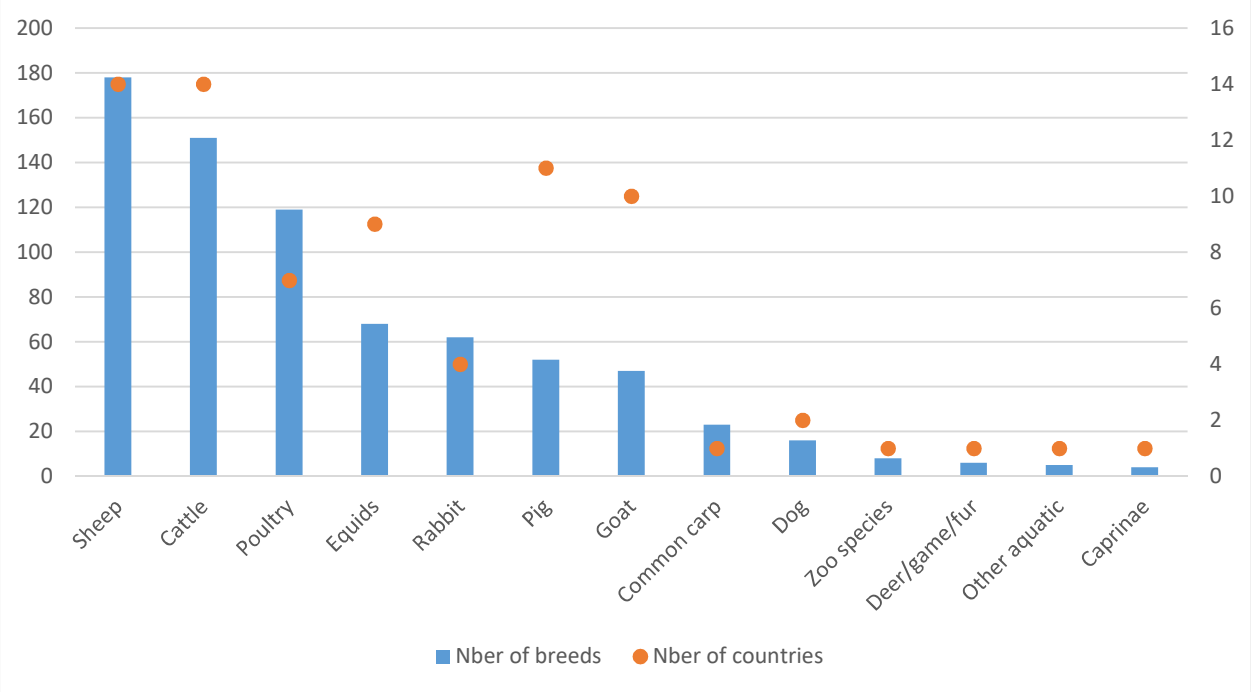
4.2. BREEDS (AND SPECIES) IN COLLECTIONS

4.2.1. GERMPLASM COLLECTIONS

QA: 76%	CR: 83%

Each organization could fill in an Excel spreadsheet in order to give details about what was in the collection. This information was very valuable in order to have an insight of the type of genetic material as well and species and breeds that were hosted. We had several issues about the data quality which varied greatly among the answers we obtained. Also, some answers were giving a different insight as far as which species are kept in the collections as shown in Figure 25: there is a much wider variety than what the first part of our questionnaire was showing (Table 7).
Overall, a total of 34 different species and 739 different breeds were mentioned in the questionnaire (Figure 25; Table 8). We tried to translate the breeds' name in an international name if it existed (for instance the German Holstein and the Polish Holstein where grouped as a single breed, the Holstein). For poultry, pig and rabbit we counted as a single line all the colors for a given breed or research lines for the same genes, however we might have missed some grouping. The total number of breeds is therefore probably slightly over evaluated. Some species mentioned in chapter 4.1 such as the Elephant or Cavia were not recorded at this level, while others were mentioned including several wild species: Aoudad, Brown bear, Chamois, Dolphin, European Mouflon, Giant Panda, Giraffe, Harris' hawk, Iberian Ibex, Koala, Muntiak, and Saharawi Dorcas gazelle. However, as we can see in Table 8, the extensive list of species is mostly "on paper", most collections for the wild species been extremely small.

Figure 25 : Number of breeds (left) and countries (right) per species



The wide variety of species shown in Table 8 is country related. For instance, all the wild species are stored in Spain, and almost ¾ of the donkey collection belongs to one breed also stored in Spain, the Catalan donkey. Rabbit is mostly kept in France, half the pig collection is owned by the Netherlands, half the sheep collection by Spain, and goat samples are mostly hosted by two countries, Austria and Spain. The sheep collection is the biggest by the number of breeds; the cattle one by the number of doses and donors. Another issue we had is that some collections provided data about their entire stock,

as an AI company, which bias the entire results since over a million doses are recorded for each AI organization (cf. Table 8). Another problem, in a lesser extent, is the case of data where a number of samples is provided without a number of donors (and the other way round), or when the number of samples per donor seemed extremely high (over 50,000 doses for a single bull for instance).

*Table 8 : Number of breeds, donors and doses **for semen only**, and countries by species*

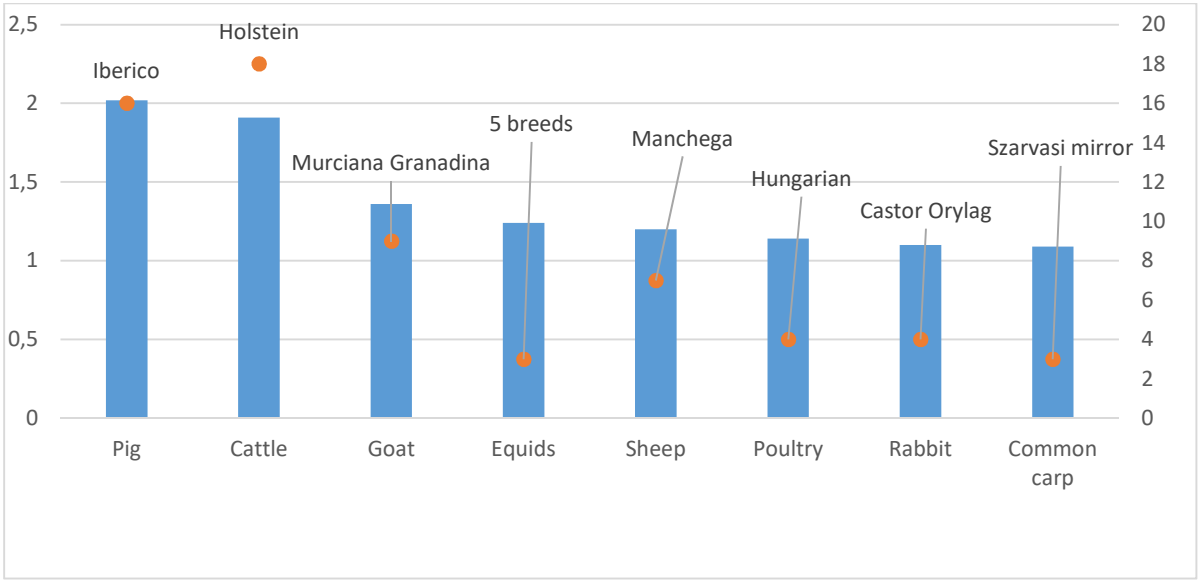
Type	Species	Number of breeds	Number of donors (semen)	Number of doses (semen)	Number of countries
Fur/pet	Mink	1	1	1	1
	Dog	16	29	803	2
Game	Deer[1]	3	39	139	1
	Other species[2]	2	7	14	1
Livestock	Cattle	151	18 736	9 157 291	14
	Donkey	5	48	15 130	2
	Goat	47	658	105 604	10
	Horse	63	510	93 010	9
	Pig	52	1 419	197 836	11
	Rabbit	62	71	2 107	4
	Sheep	178	5 009	696 756	14
Poultry	Duck	16	534	3 969	2
	Chicken	98	2 183	81 375	6
	Goose	3	58	469	3
Water species	Common carp	23	232	8 663	1
	Trout	4	143	2 736	1
	Oyster	1	199	4 027	1
Wild species	Caprinae[3]	4	313	9 843	1
	Zoo species[4]	8	17	278	1

[1] Cervus elaphus, Fallow and Roe deer
[2] Bison and Red-Leeged partridge
[3] Aoudad, Chamois, European Mouflon, Iberian Ibex
[4] Brown bear, Dolphin, Giant Panda, Giraffe, Harris' hawk, Koala, Muntiak, Saharawi dorcas gazelle

There is little redundancy among collections as shown by Figure 26 for the species with at least one breed in more than two collections, the average number of collections per breed varies between 1.09 (carp) and 2.02 (pig). The breeds with a maximum number of collections are either international breeds such as the Holstein (we can also mention the Brown Swiss cattle or the Landrace Pig with 10 collections, as well as the Charolais and Limousine cattle with 9 collections each), or Spanish breeds (Iberico, Murciana Granadina, Manchega). Half the most common cattle breed collections belonged to Spanish organizations too. The case of rabbit, fish or poultry is slightly different since the most common breeds are actually kept in a variety of different strains.

It is sometimes thought that an inventory of the European collections could be a way to rationalize collections by identifying duplicates between organizations. However limited overlap in the breeds was found between collections, except within Spain for some Spanish breeds. **This result leads us to think that most germplasm collections do detain a rather unique material.**

Figure 26 : Maximum (orange, right) and average number (blue, left) of collections per breed and species and name of the most common breed.



We might wonder if the collections stored were sufficient to be able to re-establish a breed. This also relates to the agreed Sustainable Development Goal Indicators (SDG) 2.5.1 "Number of plant and animal genetic resources for food and agriculture secured in medium or long-term conservation facilities" (FAO, 2016). According to FAO (2012), the goal to reach when restoring a breed is to create a population with an effective population size of 50.

Table 9 shows that for cattle only the average number of donors per breeds is higher than 50, indicating that for many breeds the collection stored would not be sufficient to re-establish the breed. Furthermore, details from the survey shows that the situation is worse for rare breeds compared to the larger breeds. This outcome is quite logical since it is easier to find donors in a large population than in a small one. Also, main stream breeds usually comply better with the sanitary requirements needed to enter an AI station than rare breeds do.

Table 9 : Number of donors (average, maximum) and straws (average, minimum, maximum) per breed and species – farm species and semen collections only.

	Donors		*Straws*		
	Average	Max	Average	Min	Max
Cattle	65	4 322	31 906	1	1 841 521
Goat	10	56	1 650	43	10 060
Horse/donkey	7	74	1 287	3	17 920
Pig	14	76	1 884	26	12 238
Poultry (chicken, duck etc.)	21	66	646	31	3 555
Sheep	24	524	3 271	9	54 010

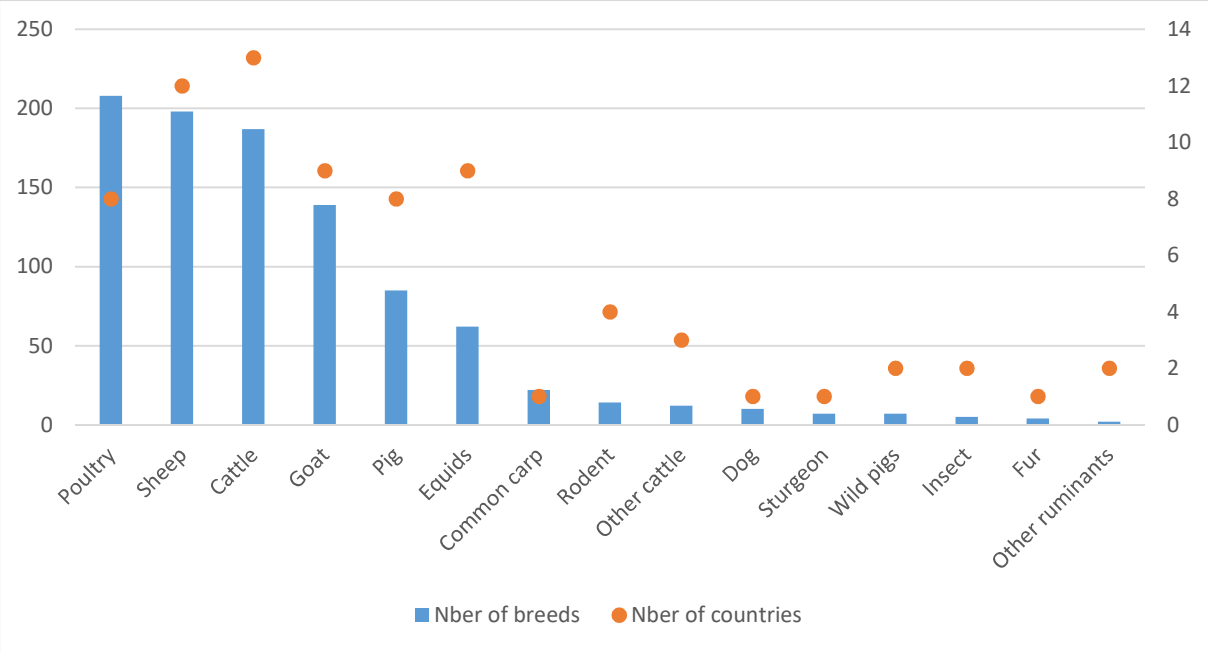
4.2.2. GENOMIC COLLECTIONS

QA: 73%	CR: 93%

An even bigger variety of species and breeds are registered in the genomic collections than in the germplasm collections since 37 different species are mentioned for 962 different breeds/strains (Figure 27). We did not ask in the questionnaire where the breeds were coming from but just by the name it appeared that there were quite a few non-European breeds, which was not the case for germplasm collections. It is much easier to collect blood samples or hair for genomic collections than

biological material, which explains probably this wider variety. However, we have to keep in mind that most collections do not have any MAA or MTA for the collection and use of biological material, therefore the status of collections from non-European countries should be checked carefully regarding compliance to the Nagoya Protocol.

Figure 27 : Number of breeds (left) and countries (right) per species



Poultry: chicken, duck, goose, guinea fowl, pheasant, turkey
Equids: donkey and horse
Rodent: guinea pig and rabbit
Other cattle: buffalo and zebu
Sturgeon: Albino starlet, Beluga sturgeon, European starlet, Russian sturgeon, Siberian starlet, Siberian sturgeon and Stellate sturgeon
Wild pigs: Babyrousa babyrussa, Phacochoerus africanus, Sus barbatus, Sus cebifrons, Sus celebensis, Sus verrucosus, Wild boar
Insect: Bee and Silk worm
Fur: mink
Other ruminants: camel and deer

The biggest collection by the number of breed is in poultry (Table 10), which includes 6 different species, chicken being ubiquitous, followed by sheep, cattle and goat with equivalent numbers. The biggest collection by sample is the goat one (over 530 000 samples) followed at a distance by cattle and sheep. Almost the whole goat collection consists in 4 different kind of genetic material (blood, hair, semen and tissue) from 124 517 different donors of the Murciana-Granadina breed for the Biogoat project. Since other samples from different goat breeds were also collected in the same project for a much smaller number of donors, we could wonder if there was not a typo mistake.

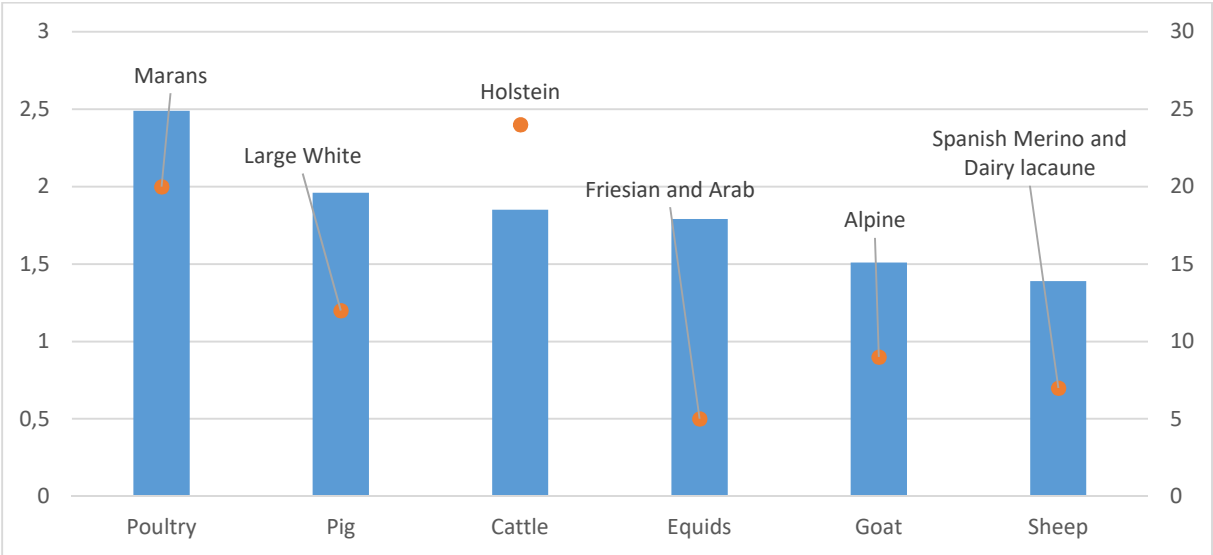
Table 10 : Number of breeds, donors, samples and countries by species

Type	Species	Number of breeds	Number of donors	Number of samples	Number of countries
Fur/Pet	Mink	4	0	19	1
	Dog	16	765	765	2
Insect	Bee /Silk worm	5	632	2 212	2
Livestock	Cattle	187	223 264	281 606	13
	Donkey	11	2 522	2 522	2

Type	Species	Number of breeds	Number of donors	Number of samples	Number of countries
	Goat	139	527 119	534 646	9
	Horse	51	28 684	29 929	8
	Pig	85	24 488	37 475	8
	Rodent	14	1 524	1 579	4
	Sheep	198	180 037	195 674	12
	Other cattle	12	492	5 731	3
	Other ruminants	2	51	52	2
Poultry	Chicken	182	11 884	22 058	8
	Duck	5	198	235	3
	Goose	3	98	98	2
	Guinea fowl	2	103	189	2
	Pheasant	3	0	3	1
	Turkey	3	914	1 069	4
Water species	Common carp	22	993	993	1
	Sturgeon	7	289	289	1
Wild species	Wild pigs	7	1 913	856	1

There is even less redundancy among genomic collections than germplasm collections (Figure 28); however, data quality was also poorer with some breeds named by numbers or with no information even for main stream species such as horse or cattle: this might have biased slightly the results. The most common breeds are mostly international ones; also, the prevalence of the Spanish collections is less important for the genomic collections than for the germplasm ones.

Figure 28 : Maximum (orange, right) and average number (blue, left) of collections per breed and species and name of the most common breed.



CONCLUSION AND PERSPECTIVES

Our survey showed that many European countries are hosting genetic collections, but they differ a lot in organization, rules and development phases. Our results are fairly representative of the overall situation for germplasm collections, however for genomic collections our sampling is probably limited and may not be representative for Europe as a whole. As far as species representation, the main livestock species are well represented. There is an extreme wide array of breeds in the collections, from rare breeds to main stream breeds, but the amount of material per breed differs also greatly and generally it is actually the endangered breeds which have the least amount of material in the collections.

A complication to access genetic collections could be that there is little formalization of the collections acquisition and access conditions, as we saw earlier with the low percentage of existing MAAs and MTAs. A reason why it might be complicated for institutions to implement such documents is ownership rights: according to our survey, 39% of the collections were owned by at least two entities or more. Also, 37 % of the collections did not belong to the organization managing the collection, which means that any use could be dependent of the owner's consent. It gives the impression that genetic collections were mostly in a phase of storing material while the process of distributing samples had not been thought through yet, and they are not ready for routine uses. Last but not least, in the case of germplasm collections, sanitary issues might limit the collections' use. As for genomic collections, their main targets for storage were quite different from germplasm collections since in most cases there were devoted to the storage of material for specific research projects. Sampling procedures were often quite complex and might involve quite a lot of task force and material.
All results showed a strong need of formalizing the position of gene banks in Europe, harmonizing practices and stimulating exchanges of knowledge and information between gene banks. The EUGENA initiative (Hiemstra et al. 2014; ERFP 2017), which is supported by the IMAGE project, is a step toward this direction.

Our survey also showed that genetic collections were mostly in the phase of storing unique genetic material whereas use was limited. The IMAGE project is a great opportunity to shift the genetic collections from a static perspective ("museum collections" with almost no flow out) to dynamic ones ("bank collections", where material flows in and out). The whole research community needs to be more aware of the relevance of this material for their projects. Also, while it is quite clear that no collections could be ever self-sustainable, economic models – including government subsidies – need to be set up to insure the future of our genetic collections. The objective is neither to deplete the collections nor to shift their objectives to a sole economic purpose, but, on the contrary to find the best way to characterize and safeguard them.

5. APPENDIX

Table 11 : List of organizations that answered the survey; categorization by activity for the Spanish germplasm collections

COUNTRY	ENTITY FULL NAME	WEBSITE	OBJECTVE (SPAIN)
AUSTRIA	AREC Raumberg-Gumpenstein, Institute of Organic Farming and Biodiversity of Farm Animals	www.raumberg-gumpenstein.at	
BELGIUM	Cryobanque wallonne	https://uclouvain.be/en/research-institutes/isv	
CROATIA	Croatian Agriculture Agency	http://www.hpa.hr/	
CZECH REPUBLIC	Department of Zoology, Faculty of Science, Charles University	https://www.natur.cuni.cz/biology/zoology/geneticka-banka	
CZECH REPUBLIC	Institute of Animal Science	www.vuzv.cz www.http://www.genetickezdroje.cz/	
FRANCE	Centre de Ressources Biologiques @BRIDGe	abridge.inra.fr	
FRANCE	Unité de Recherches Zootechniques	http://www.antilles.inra.fr/Le-centre-Les-recherches/urz	
FRANCE	GIS Cryobanque Nationale	http://www.cryobanque.org	
FRANCE	Centre de coopération internationale en recherche agronomique pour le développement	http://umr-intertryp.cirad.fr/	
GERMANY	Verein Ostfriessicher Stammviehzüchter	http://www.vost.de	
GERMANY	German gene bank for FAnGR	www.fli.de	
GERMANY			
GERMANY	Genossenschaft zur Förderung der Schweinehaltung eG	www.gfs-topgenetik.de	
HUNGARY	Ministry of Agriculture	http://www.kormany.hu/hu/foldmuvelesugyi-miniszterium	
HUNGARY	Haszonállat-génmegőrzési Központ	http://www.geneconservation.hu/	
ICELAND	Agricultural University of Iceland	www.lbhi.is	
ITALY	Consorzio di Sperimantazione, Divulgazione e Applicazione di Biotecniche Innovative	www.consdabi.org	
ITALY	Animal Germoplasm Cryobank "Giuseppe Rognoni"- IBBA-CNR	http://www.ibba.cnr.it/index.php/en/research-activities/224	
ITALY	Università Cattolica del S. Cuore	http://istituti.unicatt.it/zootecnica_index.html	
LATVIA	Scientific Laboratory of Molecular Biology and Microbiology	-	
LATVIA	Latvia University of Agriculture	http://www.llu.lv/en/	
MONTENEGRO	University of Montenegro, Biotechnical Faculty	www.btf.ac.me	
NETHERLANDS	Faculty of Veterinary Medicine, Utrecht University	www.uu.nl	
NETHERLANDS	Centre for Genetic Resources, the Netherlands (CGN), Wageningen University and Research	www.wur.nl/cgn	
POLAND	National Research Institute of Animal Production	www.izoo.krakow.pl	
PORTUGAL	National Institute for Agrarian and Veterinarian Research I. P.	http://www.iniav.pt/	
ROMANIA	AGENTIA NATIONALA DE ZOOTEHNIE	www.anarz.eu	
SLOVENIA	University of Ljubljana, Biotechnical faculty, Department of Animal Science	www.bf.uni-lj.si	

SPAIN	Aberekin Centro de Inseminación	www.aberekin.com	Commercial/Conservation
SPAIN	AGRI-FOOD RESEARCH AND DEVELOPMENT REGIONAL SERVICE	www.serida.org	Research/Conservation
SPAIN	ANIMAL BREEDING CONSULTING, SL/UNIVERSITY OF CORDOBA GR PAI AGR218)/RED CONBIAND	http://www.abcgenetica.com/	Commercial/Research/Conservation
SPAIN	Animal selection and breeding center		Conservation
SPAIN	ASTURGEN S.L.	--	Commercial/Conservation
SPAIN	Banco Nacional de Germoplasma Animal	http://www.mapama.gob.es/es/ganaderia/temas/zootecnia/razas-ganaderas/banco-nacional-germoplasma/	Conservation
SPAIN	BIOMEJÁN AGR 218 GERM BANK , UNIVERSITY OF CORDOBA	http://www.uco.es/genetica/agr218.htm	Conservation/Research
SPAIN	CENSYRA LEON - JUNTA DE CASTILLA Y LEÓN	www.censyraleon.com	Conservation/Commercial
SPAIN	CENTRO DE RECURSOS ZOOXENÉTICOS DE GALICIA	http://mediorural.xunta.gal/areas/gandaria/centro_de_recursos_zooxeneticos/	
SPAIN	Centro de Selección y Mejora de Caprino - Diputacion de Granada	www.dipgra.es	
SPAIN	Centro de Selección y Reproducción Animal de Badajoz	www.juntaex.es	
SPAIN	CENTRO DE TECNOLOGÍA ANIMAL-INSTITUTO VALENCIANO DE INVESTIGACIONES AGRARIAS	http://www.ivia.gva.es/web/cita-ivia	Research/Conservation
SPAIN	Centro de Transferencia Agroalimentaria	www.aragon.es	
SPAIN	Centro Integrado de Formación y Experiencias Agrarias de Lorca (CCAA Región de Murcia)	https://www.murciaeduca.es/ccalorca/sitio/	Conservation
SPAIN	Centro Regional de Selección y Reproducción Animal del IRIAF	http://pagina.jccm.es/agricul/cersyra/	Commercial/Conservation
SPAIN	IFAPA OF HINOJOSA CENTER	http://www.juntadeandalucia.es/agriculturaypesca/ifapa/web/ifapa/elifapa/centros	Conservation/Commercial
SPAIN	Instituto Español De Genética y Reproducción Animal	http://www.iegra.es/	Commercial/Conservation
SPAIN	Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y Alimentario	http://www.madrid.org/cs/Satellite?c=CM_Agrupador_FP&cid=1109266227162&idConsejeria=1109266187260&idListConsj=1109265444710&idOrganismo=1109266227162&language=es&pagename=ComunidadMadrid%2FEstructura&pid=1109265444699	
SPAIN	Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria	http://www.inia.es/IniaPortal/verPresentacion.action	Research/Conservation
SPAIN	Instituto Tecnológico Agrario de Castilla y León	http://www.itacyl.es/	Research/Conservation
SPAIN	Instituto Valenciano de Investigaciones Agrarias	http://www.ivia.gva.es/web/cita-ivia/	Research/Conservation
SPAIN	Laboratorio de Genética - Facultad de Veterinaria - Universidad Complutense de Madrid	http://www.ucm.es/genetvet	Research/Conservation
SPAIN	Politechnic University of Valencia	http://www.upv.es/entidades/ICTA/	Research/Conservation

SPAIN	SERVEI DE MILLORA AGRÀRIA I PESQUERA	http://semilla.caib.es/	Conservation
SPAIN	Universidad de Castilla-La Mancha	www.uclm.es	Research/Conservation
SPAIN	University Autonomous of Barcelona	http://www.uab.cat	Research/Conservation
SPAIN	University of Huelva	www.uhu.es	Research/Conservation
SPAIN	Unniversitat Autònoma de Barcelona	http://www.uab.cat/	Research/Conservation
SPAIN	Aberekin Centro de Inseminación	www.aberekin.com	Commercial/Conservation
SWEDEN	Swedish Board of Agriculture	www.jordbruksverket.se	
UK	Rare Breeds Survival Trust	www.rbst.org.uk	
UK	The Sheep Trust	www.sheeptrust.org.uk	
UKRAINE	Institute of Farm Animal Breeding and Genetics	http://iabg.org.ua	