

Collaborative action for updating the documenting about berry genetic resources in Europe

EUROPE.BERRIES

Period (01.11.2021 – 28.02.2023)

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INTRODUCTION

With the establishment of the Berries Working Group in 2019, the first need was to obtain an overview of the existing genetic resources in the different European countries. For this reason, possible future projects were discussed at the first meeting of the Working Group (WG) in Dresden in January 2020. The project 'Collaborative action for updating the documenting about berry genetic resources in Europe' (EUROPE.BERRIES) was submitted and approved as part of the ECPGR Activity Grant Scheme – Phase X in the 4th call.

The Joint Action for 'Updating the documenting about berry genetic resources in Europe' contributes to the following ECPGR objectives: (1) Record the varieties/cultivars of berry genetic resources in the respective participating countries, and provide data harmonization, qualitative evaluation and availability for inclusion to the respective National Focal Points for EURISCO; (2) Elaborate a first draft of crop-specific technical guidelines for genebank management (Manuals) of berry genetic resources and publish any related article.

The outcome of the above-mentioned objectives will provide the basis for the future work of the Berries Working Group. Following the detailed inventory by which berry genetic resources are conserved under different conditions in European genebanks, further projects will focus on both phenotypic and molecular characterization of European genebanks to identify unique accessions for inclusion in AEGIS in the future. The EURISCO descriptors for the template were discussed with Stephan Weise (IPK Gatersleben, Germany) responsible for the EURISCO database.

Seventeen partners of the WG sent an 'Expression of Interest' to participate in the ECPGR Activity and one further partner would participate as a self-funded partner.

In preparation for the project, the WG coordinator requested inventories of the respective genebanks of the WG partners. **First, the varieties/cultivars of the berry genetic resources had to be recorded.** The query was carried out according to the [EURISCO passport descriptors](#) and contained information on the preserved accessions, but also additional information on the trueness-to-type of the variety and the virus status of the accession were included.

Altogether, 17 inventories from partners from 16 countries were available at the beginning of the project. The partners sent inventories separated into the genera *Fragaria*, *Rubus*, *Ribes*, *Vaccinium* and other berry species: 15 inventories of *Fragaria*, 14 of *Rubus*, 13 of *Ribes*, 8 of *Vaccinium* and 8 of other minor species.

In preparation for the project, partners were also asked whether they would be interested in evaluating the respective inventories of a genus as a member of a project-working group. The participation and responsibilities of the individual partners of the project can be seen in Table 1.

Table 1: Participation of the project partner in providing inventories separated into the genera *Fragaria*, *Rubus*, *Ribes*, *Vaccinium* and other berry species as well as as member of the project group.

Partner ID No.	Member project group	Country	Institutsname	<i>Fragaria</i>	<i>Rubus</i>	<i>Ribes</i>	<i>Vaccinium</i>	Other genera
1	x	Lithuania	Lithuanian Research Centre for Agriculture and Forestry	1		1		
2	x	Germany	Federal Plant Variety Office - Testing Station Wurzen	1	1	1		
3	x	Finland	Natural Resources Institute Finland (Luke)	1	1	1	1	1
4	x	Slovenia	Agricultural Institute of Slovenia		1	1	1	1
5	x	Greece	Institute of Plant Breeding and Genetic Resources – HAO Demeter	1	1	1	1	1
6	coordinator	Germany	Julius Kühn Institute, Institute for Breeding Research on Fruit Crops	1	1			1
7		Czech Republic	Research and Breeding Institute of Pomology Holovousy Ltd.	1	1	1	1	1

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8	Estonia	Estonian University of Life Science	1	1	1	1	
9	France	INRAE	sent passport data				
10	France	INVENIO	1				
11	Italy	CREA Research Centre for Olive, Fruit and Citrus Crops	1				
12	Latvia	Institute of Horticulture LATHORT	1	1	1	1	
13	Norway	Njøs Fruit and Berry Centre	1	1	1	1	
14	Romania	Research Institute for Fruit Growing	1	1	1	1	
15	Sweden	SLU/ Swedish National Genebank	1	1	1	1	
16	Schweiz	ProSpeciaRara	1	1	1	1	
17	Albania	Agricultural University of Tirana		1		1	
18	Turkey	University of Cukurova	1	1	1	1	
Total			15	14	13	8	11

MATERIALS AND METHODS / APPROACH

With the confirmation of the project proposal, three video conferences were held with all members of the project-working group for the respective work steps:

- 1st Activity meeting, online, 21 April 2021
- 2nd Activity meeting, online, 28 September 2021
- 3rd Activity meeting, online, 4 May 2022

1. To provide passport and phenotypic information of actively conserved European PGRFA diversity *ex situ* through the EURISCO catalogue

In the first phase of the work, the above-mentioned members of the project group collected the inventories of berry genetic resources, which were prepared in advance of the project by all partners in 2020. Subsequently, the members of the project group asked the partners for the missing data of the template or even for additional accessions, and to create a unified list of the accessions for each genus with a deadline of September 2021.

The next steps for the project-group members were (1) the revision of the accessions list concerning taxonomy (species) and variety names and (2) the integration of passport data. During the 2nd video conference, all the questions that arose on the descriptors of the query in order to work consistently on the above two objectives were discussed. It was decided to use the GRIN Taxonomy, if possible (<https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch>). For the final processing of the inventory lists, cross-cutting questions were discussed: among other things, the spelling/naming of the leading name of a variety, further processing of missing passport data, etc.

Passport data could be used from both the EU GENBERRY project (INRAE, France) project database and the RIBESCO project (Luke, Finland). These data were sent by the project coordinator to the responsible project-group members.

2. Elaboration of crop-specific technical guidelines for genebank management of berries genetic resources

Based on the results of the first request regarding the forms of preservation, the WG coordinator developed a template, which was sent to all project partners, in order to request detailed methods of conservation. The questionnaire contained exact questions on the cultivation of the plants for the *ex situ* collection in the field or the greenhouse as well as for the *in vitro* and cryo collection.

Based on the answers to the questionnaires, a first draft of crop-specific technical guidelines for genebank management of berry genetic resources was elaborated.

RESULTS

1. To provide passport and phenotypic information of actively conserved European PGRFA diversity *ex situ* through the EURISCO catalogue

In the course of the project, the members of the project actively worked on the verification and completion of the inventories for the respective genera according to EURISCO (Revision of the lists concerning taxonomy and cultivar names; Integration of passport data): Rytis Rugienius and Audrius Sasnauskas were responsible for the genus *Fragaria*; Erika Schulte for the genus *Rubus*; Saila Karhu for the genus *Ribes*; Darinka Koron for the genus *Vaccinium* and Eleni Maloupa and George Pantelidis were responsible for the 'other genera of berry genetic resources'.

Differing indications of GENUS, SPECIES, and CROPNAME were adjusted according to GRIN Taxonomy. Variety denominations were adjusted according to the rule that a variety's name is considered the original one, which is used in the country of its origin, as far as the denomination has not been agreed upon and used in a differing way in any kind of common EU register (like FRUMATIS). All other known denominations, whether submitted by the partners or taken from pomological literature, of a variety have been listed as known synonyms.

Passport data have been included, partly from the individual partners' side (e.g. INSTCODE, ACCENUMB, ACQDATE, ORIGCTY, COLLSITE, SAMPSTAT, DONORNAME, STORAGE, Virus state, and Variety check), or added by the project members upon availability from the pomological literature available (e.g. BREDNAME, ANCEST).

Altogether 4,061 accessions of berry genetic resources were mentioned in the inventories (Figure 1).

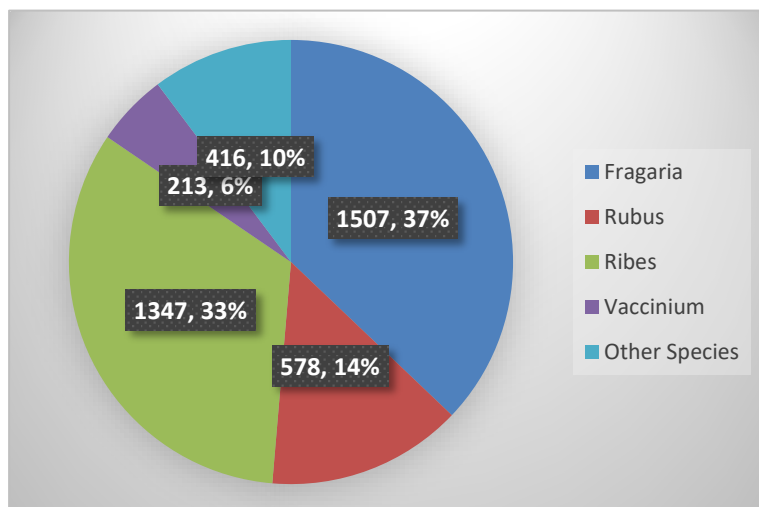


Figure 1: Presentation of the number of accessions of the genera in total in the collections of berries genetic resources at the participating European partners of the project.

At the beginning of the project, the project group discussed what are genetic resources in berries and what should be included in particular in the term 'other genera of berry genetic resources'. In botanical terminology, a berry is a simple fruit with seeds and pulp produced from the ovary of a single flower, in which the complete pericarp is still juicy or at least fleshy when ripe (Kiger and Porter, 2001).

Traditionally and in everyday language, the term has different meanings and is usually used for small, sweet fruits, and the berry fruit. Berries under both definitions include blueberries, cranberries, lingonberries, and the fruits of many other members of the heather family, as well as gooseberries (*Ribes* L.), goji berries (*Lycium* L.) and elderberries (*Sambucus* L.) The fruits of currants (*Ribes* L.), such as blackcurrants, red currants and white currants, are botanical berries, even though their most commonly used names do not include the word 'berry'. On the other hand, several different kinds of fruit commonly called berries are not botanical berries. Blackberries, raspberries, and strawberries are aggregate fruit; they contain seeds from different ovaries of a single flower.

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On this basis, the following genera and species should be considered in the term 'other genera of berry genetic resources' (Table 2) and an additional query was sent to all project partners to ask more in detail. A detailed list of all species is shown in the following table.

Table 2: Presentation of the number of accessions for the detailed species in the berry genetic resources collections of the European project partners. The most frequent species are marked in grey.

GENUS	SPECIES	No Acc	GENUS	SPECIES	No Acc
<i>Fragaria</i>	<i>chiloensis</i>	11	<i>Vaccinium</i>	<i>angustifolium</i>	2
<i>Fragaria</i>	<i>hybr.</i>	3	<i>Vaccinium</i>	<i>corymbosum</i>	113
<i>Fragaria</i>	<i>moschata</i>	69	<i>Vaccinium</i>	<i>hybrid</i>	16
<i>Fragaria</i>	<i>spp.</i>	1	<i>Vaccinium</i>	<i>macrocarpon</i>	8
<i>Fragaria</i>	<i>vesca</i>	51	<i>Vaccinium</i>	<i>myrtillus</i>	51
<i>Fragaria</i>	<i>virginiana</i>	4	<i>Vaccinium</i>	<i>oxycoccus</i>	1
<i>Fragaria</i>	<i>viridis</i>	1	<i>Vaccinium</i>	<i>sp.</i>	4
<i>Fragaria</i>	<i>x ananassa</i>	1,355	<i>Vaccinium</i>	<i>spp.</i>	3
<i>Fragaria</i>	<i>x vescana</i>	12	<i>Vaccinium</i>	<i>uliginosum</i>	1
			<i>Vaccinium</i>	<i>vitis-idaea</i>	14
<i>Rubus</i>	<i>idaeus</i>	439	<i>Actinidia</i>	<i>arguta</i>	7
<i>Rubus</i>	<i>sect. Rubus</i>	86	<i>Amelanchier</i>	<i>alnifolia</i>	5
<i>Rubus</i>	<i>occidentalis</i>	14	<i>Amelanchier</i>	<i>ovalis</i>	1
<i>Rubus</i>	<i>arcticus</i>	10	<i>Aronia</i>	<i>x prunifolia</i>	1
<i>Rubus</i>	<i>hybr.</i>	16	<i>Aronia</i>	<i>melanocarpa</i>	4
<i>Rubus</i>	<i>x binatus</i>	4	<i>Cornus</i>	<i>mas</i>	17
<i>Rubus</i>	<i>idaeus x allegheniensis</i>	2	<i>Hippophae</i>	<i>rhamnoides</i>	93
<i>Rubus</i>	<i>phoenicolasius</i>	2	<i>Lonicera</i>	<i>x caerulea</i>	2
<i>Rubus</i>	<i>allegheniensis</i>	2	<i>Lonicera</i>	<i>caerulea</i>	27
<i>Rubus</i>	<i>chamaemorus</i>	1	<i>Mahonia</i>	<i>aquifolium</i>	1
<i>Rubus</i>	<i>nessensis</i>	1	<i>Morus</i>	<i>alba</i>	112
<i>Rubus</i>	<i>ulmifolius</i>	1	<i>Morus</i>	<i>nigra</i>	25
			<i>Morus</i>	<i>rubra</i>	2
<i>Ribes</i>	<i>aureum</i>	4	<i>Morus</i>	<i>sp.</i>	22
<i>Ribes</i>	<i>dikusha</i>	1	<i>Rosa</i>	<i>canina</i>	9
<i>Ribes</i>	<i>nigrum</i>	451	<i>Rosa</i>	<i>damascena</i>	1
<i>Ribes</i>	<i>rubrum</i>	442	<i>Rosa</i>	<i>dumalis</i>	1
<i>Ribes</i>	<i>x niveum</i>	4	<i>Sambucus</i>	<i>nigra</i>	51
<i>Ribes</i>	<i>spicatum</i>	12	<i>Sorbus</i>	<i>x hybrida</i>	1
<i>Ribes</i>	<i>uva-crispa</i>	431	<i>Sorbus</i>	<i>x meinichii</i>	1
<i>Ribes</i>	<i>x nidigrolaria</i>	1	<i>Sorbus</i>	<i>aucuparia</i>	24
<i>Ribes</i>	<i>spp.</i>	1	<i>Sorbus</i>	<i>intermedia</i>	2
<i>Ribes</i>	<i>sp.</i>	2	<i>Sorbus</i>	<i>latifolia</i>	1
			<i>Sorbus</i>	<i>rupicola</i>	1
			<i>Sorbus</i>	<i>sp.</i>	5

For *Fragaria*, the common list contained 762 different *F. ×ananassa* cultivars. Among them, 537 were unique accessions, stored in only one of the collections. Some cultivars (Honeoye, Senga Sengana) are held in almost all collections. Information on the virus status of strawberries and the method of cultivar identification in various institutions was also collected. Among the accessions, 67.1% of the virus status was unknown, 30.7% were virus tested, and 2.2% were virus-free certified. Pomological description of accession was the most frequent method for variety identification, but also molecular technology was in use in some institutes: for 67% of the mentioned accessions, pomological and/or molecular trueness-to-type determination had already been carried out.

In *Rubus*, there are 439 cultivars of raspberry (*R. idaeus*), 86 cultivars of blackberry (*R. subgen. Rubus*) and 14 cultivars of black raspberry (*R. occidentalis*) in the collections recorded. Eight varieties of *Rubus idaeus* L., and two varieties of *Rubus* sect. *Rubus*, were chosen for future use in subsequent projects of the ECPGR Berries WG. These are in particular: (*R. idaeus*) 'Heritage', 'Meeker' (both currently maintained by six partners of the ECPGR Berries WG), 'Malling Promise', 'Schönemann' (both currently maintained by five partners of the ECPGR Berries WG), 'Autumn Bliss', 'Golden Queen', 'Lloyd George', 'Malling Exploit' (all four currently maintained by four partners of the ECPGR Berries WG), and (*Rubus* sect. *Rubus*) 'Black Satin' (currently maintained by four partners of the ECPGR Berries WG), and 'Loch Ness' (currently maintained by three partners of the ECPGR Berries WG). Three hundred and ten varieties are only in one collection. For 41% of the mentioned accessions, pomological and/or molecular trueness-to-type determination had already been carried out.

Also for ***Ribes*** pomological description of accession was most frequent method for variety identification, but also molecular technology was in use in some institutes: for 57% of the mentioned accessions, pomological and/or molecular trueness-to-type determination had already been carried out. Three varieties of *Ribes nigrum* L., six varieties of *Ribes rubrum* and three of *Ribes uva-crispa*, were chosen for future use in subsequent projects of the ECPGR Berries WG. These are in particular: (*Ribes nigrum*) 'Brodtorp', 'Titania' and 'Öjebyn', (*Ribes rubrum*) 'Blanka', 'Jonkheer van Tets', 'Junifer', 'Red Lake', 'Rote Hollandische' and 'Rovada' and (*Ribes uva-crispa*) 'Captivator', 'Hinnonmaen Keltainen', 'Invicta'.

According to Table 1, only eight institutions have collections of ***Vaccinium*** so the number of accessions is also limited. Darinka Koron, responsible for the genus *Vaccinium*, reported that she processed the inventories of eight already reported partners and two additional partners: Fondazione Fojanini di Sondrio, Italy and the National Institute of Horticultural Research in Skierniewice, Poland. A total of 213 accessions belonging to eight defined species were reported (main cvs. of *Vaccinium corymbosum* 113 acc.; *Vaccinium myrtillus* 51 acc.). Only for 17% of the mentioned accessions, pomological and/or molecular trueness-to-type determination had already been performed.

Based on the discussion about the definition of berry genetic resources, another specific request was sent to the partners for the **'other genera of berry genetic resources'**. Altogether, 161 acc. of *Morus* (mulberry), 51 acc. of *Sambucus nigra* (elderberry), 93 acc. of *Hippophae rhamnoides* (Sea buckthorn) and 35 acc. of *Sorbus aucuparia* (rowanberry) were reported.

The last target for the members of the project group was to send the revised inventory lists to the JKI, Institute for Breeding Research on Fruit Crops as the coordinator of the project by the end of 2022.

After a final assessment the WG Chair, coordinator of the project, submitted the revised lists to each project partner at the end of February 2023. In this email, in addition to the revised inventories, information was given explaining how the inventories should then be transferred to the EURISCO database via the National Focal Point of each country.

Furthermore, each member of the project was asked to check the existing inventories and make suggestions for varieties/accessions to be used for further projects on characterization (phenotypic/molecular) to finally identify unique accessions for inclusion in AEGIS in the future. These suggestions were given for the genera *Fragaria*, *Rubus* and *Ribes* in the above-written part.

2. Elaboration of crop-specific technical guidelines for genebank management of berry genetic resources

The first query on the existing accessions also included the descriptor 'Type of germplasm storage' (EURISCO 26 – STORAGE). Most of the temperate fruit species are genetically heterozygous and vegetatively propagated. The collections of berry genetic resources are maintained in the field or greenhouses as active plantations where the accessions are available for characterization, evaluation and distribution. Backups for the plant material are needed to provide security in case of a disease or an environmental disaster. The duplicate collection could be a second field site, an *in vitro* culture or cryopreservation.

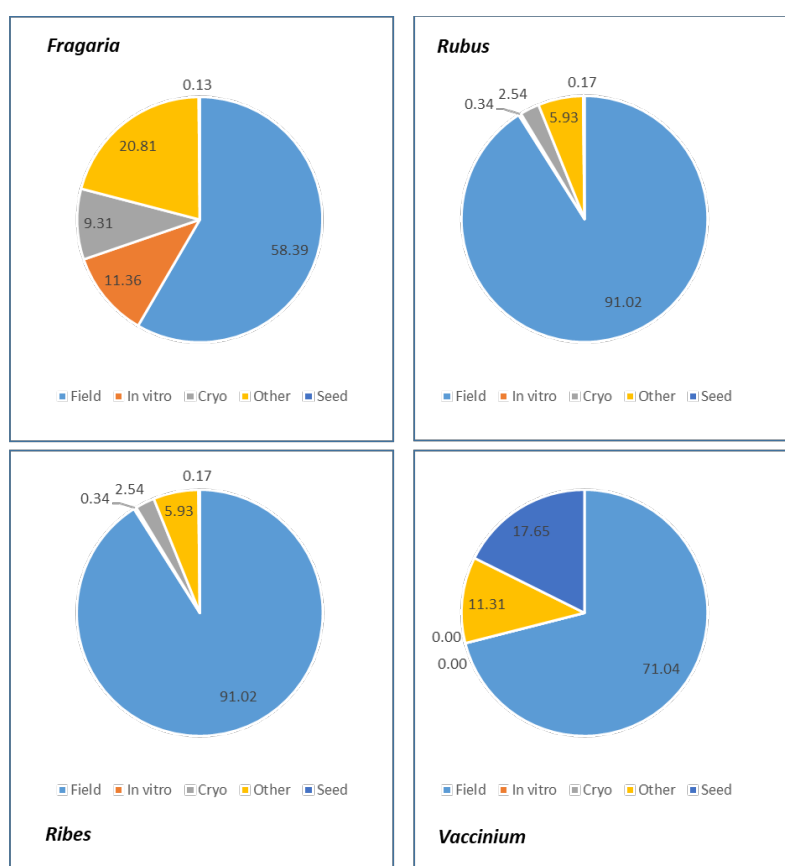


Figure 2: Descriptor 'Type of germplasm storage' – Percentages for conservation of the accessions in field, *in vitro*, cryopreservation or seed collection for the different genera of berry genetic resources.

Based on Figure 2, only in the case of *Fragaria* the *in vitro* culture and cryopreservation make a significant contribution to safety-duplication.

The second template, which was sent to all project partners to request detailed conservation methods, was also completed by all partners. Detailed information was asked for *ex situ*, *in vitro* and cryo collections. For the *ex situ* collections, the following points were included:

Location of the genebank	Soil	Type of planter containers
Type of plants	Which plant labels are used?	How many plants per accession?
Planting time	Isolation distance of the plants (cm/m)	Field management
Horticultural work	How is the phytosanitary control organized?	Pest and diseases control
Disease prevention / integrated pest management	Replanting time of the plantation	How is the replantation realized?
Periodically verifying the identity of the accession	Could you realize characterization / evaluation work?	Safety duplication

The contributions were provided by 18 partners by the end of April 2022, so that the preparation of the first draft of crop-specific technical guidelines for genebank management of berry genetic resources could be started. The *Prunus*-specific standards for genebank management should serve as an example (Giovannini et al. 2016).

This first draft will be sent to all WG members for discussion after the end of the project. The aim is to establish quality standards for the conservation of berry genetic resources and to publish these according to the template for crop-specific field genebank standards on the ECPGR website.

CONCLUSION

The Activity development was planned mainly in relation to ECPGR Objectives 1 and 2.

- The created inventories of accessions of varieties/cultivars of berry genetic resources in a qualitative uniform manner provide information about berry germplasm actively conserved *ex situ* in the participating European countries and will finally be documented through the EURISCO catalogue.
- The first draft of crop-specific technical guidelines for genebank management of berry genetic resources is the basis to establish quality standards of conservation for unique berry germplasm in the European Collection.
- For the genera of berries with the most accessions (*Fragaria*, *Rubus* and *Ribes*), cultivars were selected to form the basis of further projects. The aim is to start further projects on characterization (phenotypic/molecular) to identify unique accessions for future inclusion in AEGIS.
- The following publications were made on the activities of the ECPGR Berries WG within the time frame of the project:
 - Höfer, M. 2022. Coordination of genebank activities between different national collections of berry genetic resources in Europe in the frame of ECPGR. Poster. XXXI International Horticultural Congress: IHC2022, Angers August 14 – 20 2022.

- Höfer, M. 2022. Tutelare la biodiversità dei piccoli frutti con una banca genetica. *Frutticoltura* n.3. marzo, 36 – 39.
- Höfer, M. 2021. [Coordination of genebank activities between different national collections of berry genetic resources in Europe in the frame of ECPGR](#) (608,2 KB). *Acta Hortic.* 1309. ISHS 2021. DOI 10.17660/ActaHortic.2021.1309.27, Proc. IX International Strawberry Symposium, Eds.: B. Mezzetti et al.
- Petit, A. 2021. [Enrichir nos ressources génétiques fraise à l'échelle européenne](#) (363,1 KB). *Infos Invenio*, 24.

All the objectives of the EUROPE.BERRIES project were achieved. An extension to the initially planned period was requested due to different reasons. The main reason was that for some partners, working with the EURISCO passport data was new terrain, so extensive explanations were necessary and the work was delayed. The situation was the same for the individual members of the project group who had volunteered to revise passport data.

RECOMMENDATIONS – PERSPECTIVE

This action gave the newly established WG the opportunity to work together for the first time within the ECPGR framework and to make themselves known with their working methods.

A grant will be requested for a second group meeting to present the results to a majority of the members and to discuss further projects and define responsibilities. The results of the project will also be presented at the next Progress Meeting of the EU project 'Breeding value' in order to identify further synergies for further work on genetic resources in berries.

The project was the basis for establishing the first step towards a long-term infrastructure for the conservation, characterization, documentation and utilization of genetic resources in berries.

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- <https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch>



ANNEX 1

Berry-specific standards for *ex situ* genebank management

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1. Draft

Genebank activities	<i>Berry-specific standards recommended by the ECPGR Berries Working Group</i>	Corresponding section of the FAO Genebank Standards (ref. 1)
1. Choice of location of the genebank	<p>Standards for choice of location of the field genebank</p> <p>An appropriate site and a sufficient number of healthy plants per accession should be ensured for safety and characterization. The planting site(s) should be selected to minimize major physical, chemical and biological soil problems and to maximize physical security. The safety of the collection is a priority of every genebank.</p> <ul style="list-style-type: none"> • <i>Collections of berry genetic resources are held in a greenhouse or in the field.</i> • <i>If possible, a core collection should be stored as potted plants under insect-proof screens with an active integrated pest management programme to reduce the risk of virus infection</i> 	Section 5.1
2. Germplasm acquisition and accessioning	<p>All germplasm accessions added to the genebank should be legally acquired and abides by national, regional and international phytosanitary and any other import regulations and requirements</p> <ol style="list-style-type: none"> 1. Phytosanitary requirements: All incoming material is checked for damage/contamination. Samples acquired from other countries or regions within the country should pass through the relevant quarantine process and meet the associated requirements before being incorporated into the collection. 2. Legal requirements: International Treaty on Plant Genetic Resources for Food and Agriculture (SMTA); Convention on Biological Diversity (PIC and MAT) 3. When registering an accession in the genebank documentation system: <p>Add to the genebank register all relevant FAO/Bioversity Multi-crop passport descriptors, at least the minimum list of passport data: ACCENUMB, GENUS, SPECIES (if known), ACCENAME (if existing), and ORIGCTY (if known).</p> <p>If germplasm has been acquired by the genebank through collecting missions, it is recommended to add in the genebank register available information about the location of the collecting site (appropriate FAO/Bioversity Multi-crop passport descriptors n°14 to 16).</p> <p><i>Berry germplasm sources:</i></p> <ul style="list-style-type: none"> • <i>Collecting missions</i> • <i>Germplasm exchange</i> • <i>Donation from researchers and breeders</i> 	Section 5.2. (see also 5.8.)

Genebank activities	Berry-specific standards recommended by the ECPGR Berries Working Group	Corresponding section of the FAO Genebank Standards (ref. 1)
3. Establishment of collections	<p>Standards for the establishment of field collections</p> <ol style="list-style-type: none"> 1. Ensure a sufficient number of plants/accession. 2. The growth habit and the adult size of the plant need to be considered when calculating the spacing among the plant. 3. Develop, maintain and update detailed field maps, as a backup to labels <ul style="list-style-type: none"> • <i>The number of plants per accession depends on the conditions the task of the institution but should be at least three for Fragaria, Ribes, Vaccinium and Rubus.</i> • <i>Especially for Rubus, Ribes and Vaccinium, space each plant in the collection widely enough to allow regular growth, vegetative renewal and cropping.</i> • <i>Depending on the number of plants per accession, the single plant or plot is labelled in berry genetic resources.</i> 	Section 5.3.
4. Management of collections	<p>Standards for field management</p> <ol style="list-style-type: none"> 1. Plants and soil should be regularly monitored for pests and diseases. Inspect visually the plants in the collection, at least once a year. The timing of inspections should match the moment of highest visibility of symptoms for the specific crop species. Phytosanitary treatments should be applied whenever needed. 2. Appropriate cultivation practices such as fertilization and irrigation should be performed to ensure satisfactory plant growth. A good standard practice should ensure not only plant survival but also reliable characterization and enough material available for distribution. 3. The genetic identity of each accession should be monitored by ensuring proper isolation of accessions wherever appropriate, avoiding inter-growth of accessions – regular controls of mainly morphological and phenological traits. <ul style="list-style-type: none"> • <i>The growing conditions (planting distances, cultivation methods and dates, planting containers, soil, etc.) vary depending on the different genera of berry genetic resources.</i> 	Section 5.4.

Genebank activities	<i>Berry-specific standards recommended by the ECPGR Berries Working Group</i>	Corresponding section of the FAO Genebank Standards (ref. 1)
5. Regeneration / Propagation	<p>Standards for regeneration and propagation</p> <ol style="list-style-type: none"> 1. Each accession in the field collection should be regenerated when the vigour and/or plant numbers have declined to critical levels in order to bring them to the original levels 2. True-to-type healthy plant material should be used for propagation 3. Information regarding plant regeneration cycles and procedures including date, authenticity of accessions and labels should be properly documented. <ul style="list-style-type: none"> • <i>Each accession in the field collection should be regenerated/repropagated according to the given institutional conditions.</i> • <i>The type and frequency of propagation are determined by the specific genus – in Fragaria at least every two years by runners, in Rubus between 2–10 years by roots cuttings, in Ribes between 2–40 years by shoot cuttings, in Vaccinium between 2–30 years by cuttings.</i> 	Section 5.5.
6. Characterization/ evaluation	<p>Standards for characterization and evaluation</p> <ol style="list-style-type: none"> 1. For each accession, a representative number of plants should be used for characterization. 2. Accessions should be characterized morphologically using internationally agreed descriptor lists (see references no. 3–10). 3. Evaluation data on field genebank accessions should be obtained for traits of interest and in accordance with internationally used descriptor lists (see references no. 3–10). 4. The methods/protocols, formats and measurements for evaluation should be properly documented with citations. 5. Evaluation trials should be replicated as appropriate and based on a sound statistical design. <ul style="list-style-type: none"> • <i>UPOV for the different genera of berry genetic resources; COST action 836 "Integrated research in berries"; Bioversity International. Genera-specific documents listing the set of First (FPD) and Second (SPD) priority descriptors will be developed by the Working Group (WG).</i> • <i>Molecular tools are also important to confirm accession identity and trueness to type (acc. AGRI GEN RES 036 EU GENBERRY; RIBESCO, Breeding Value project). The WG recognizes the importance to standardize the set of molecular markers, the DNA extraction and PCR protocols in order to harmonize genotyping of accessions and facilitate data comparison, a common set will be discussed by the WG.</i> 	Section 5.6. / 5.7.

Genebank activities	Berry-specific standards recommended by the ECPGR Berries Working Group	Corresponding section of the FAO Genebank Standards (ref. 1)
7. Documentation	Standards for documentation <ol style="list-style-type: none"> 1. Passport data for all accessions should be documented using the FAO/Bioversity multi-crop passport descriptors (see also 2. Germplasm Acquisition and Accessioning; reference no. 2) 2. Field management processes and cultural practices should be properly recorded and documented 3. Data from points 2. and 5. should be stored and changes updated in an appropriate database system and international data standards adopted (see reference no. 1). Passport data should be updated regularly in EURISCO http://eurisco.ecpgr.org/ 	Section 5.8.
8. Distribution	Standards for distribution <ol style="list-style-type: none"> 1. All germplasm should be distributed in compliance with national laws and relevant international treaties (e.g. SMTA of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA); Nagoya Protocol) and conventions. <i>Fragaria</i> is belonging to Annex 1 crops of the ITPGRFA. 2. All samples should be accompanied by relevant phytosanitary documents as required by the donor and the recipient country. 3. Associated information should accompany any germplasm being distributed. 	Section 5.9.

Genebank activities	<i>Berry-specific standards recommended by the ECPGR Berries Working Group</i>	Corresponding section of the FAO Genebank Standards (ref. 1)
9. Safety duplication	<p>Standards for security and safety duplication</p> <p>Every field genebank accession should be safety-duplicated at least in one more site and/or backed up by an alternative conservation method/strategy such as <i>in vitro</i> or cryopreservation where possible. A legal agreement setting out the responsibilities of the depositing and the recipient genebank is necessary.</p> <ul style="list-style-type: none"> • <i>Collections of berry genetic resources are maintained in the field as active collections to preserve the unique heterozygotic individuals that have been identified and selected for their special combination of genetic attributes. Safety backups of the plant material in active collections are needed to provide security in case of a disease or environmental disaster.</i> • <i>A safety backup collection comprises accessions of an active collection at different locations; i.e. maintained at a second site as a field collection (like the German Fruit Genebank https://www.deutsche-genbank-obst.de; Middle Black Sea Transitional Zone Agricultural Research Institution), or</i> • <i>in greenhouses (Swedish Elite Plant Station),</i> • <i>or held as in vitro cultures in the laboratory as short- and medium-term storage or cryopreserved as long-term storage.</i> • <i>The guidelines in the FAO Genebank Standards for ‘in vitro culture and slow growth storage’ and ‘cryopreservation’ are valid and applicable also to genebanks of berry genetic resources (ref. no. 1).</i> • <i>Technical documents detailing optimal conditions for the application of these storage techniques to the various berry genera need to be developed by the WG.</i> 	Section 5.10

References

1. FAO Genbank Standards for Plant Genetic Resources for Food and Agriculture (2014) <https://www.fao.org/3/i3704e/i3704e.pdf>
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9. UPOV, Schwarze Johannisbeere, TG/40/7, 2008-04-09
10. International Board for Plant Genetic Resources (IBPGR); Commission of the European Communities (CEC) (1986) Strawberry descriptors. International Board for Plant Genetic Resources 24 p. Strawberry descriptors <https://hdl.handle.net/10568/72947>