The documentation of ex situ collections of Plant Genetic Resources in Spain

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1. Current status of the Spanish Network of ex situ collections

Spain is one of the richest countries in biodiversity and crop biodiversity in Europe. Significant efforts have been made in the last decades to collect genetic resources of improved varieties, landraces and wild plant populations and to ensure their long-term conservation in ex situ collections, thus preventing their irreversible lost. Spanish ex situ collections of plant genetic resources for food and agriculture (PGRFA) are organized in a National Network supported by the National Programme on Conservation and Utilization of PGRFA. Currently, 35 public institutions maintain a total of 75,135 accessions in their PGRFA collections, including both seed and field collections (Fig. 1).

![Map of the 35 institutions participating to the National Network of ex situ PGRFA collections.](image)

The INIA’s Centre for Plant Genetic Resources (CRF), in addition to its work in maintaining active collections of cereals and grain legumes and conserving safety duplicates of all seed collections of the network, is responsible for the documentation of the national network. Following this mandate, CRF developed in 2000 the National Inventory of PGRFA (NI), which is regularly updated and available on-line\(^1\), in Spanish and English. Table 1 shows the number of accessions reported by each of the 35 participating institutions.

The Banco de germoplasma vegetal “Cesar Gomez Campo” hosted by the Technical University of Madrid is one of the oldest and most valuable collections of the Network, conserving an important representation of wild and threatened plant species of the Mediterranean area. Also the Research Centre La Orden in Badajoz keeps a remarkable collection of forage legume (Trifolium, Medicago) and lupine germplasm. In the area of vegetatively propagated crops, it is worth mentioning the Olive World Collection maintained in Cordoba by

\(^1\) [http://wwwx.inia.es/webcrf](http://wwwx.inia.es/webcrf)
IFAPA as well as the IMIDRA Vitis collection in Madrid. Given the economic importance of vineyard in Spain, a project aimed at gathering and analyzing the information on the germplasm conserved in a number of institutions is currently underway. In the group of vegetable species, the COMAV genebank in Valencia and the CITA collections in Zaragoza are the national references, although the dispersal of germplasm in several institutions calls for a rationalization of the resources, which has already been initiated. Finally, the collections maintained by CCBAT and ICIA in Tenerife and IRFAP in Majorca include unique indigenous germplasm from the Canary and Balearic islands respectively.

**Table 1. – Germplasm collections and number of accessions held by the institutions of the Network**

<table>
<thead>
<tr>
<th>FAO CODE</th>
<th>INSTITUTION</th>
<th>MAIN COLLECTIONS</th>
<th>Accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESP003</td>
<td>U. P. Madrid - Banco de Germoplasma Vegetal</td>
<td>Wild species, crucifers</td>
<td>9,218</td>
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<tr>
<td>ESP004</td>
<td>INIA - Centro Nacional de Recursos Fitogenéticos</td>
<td>Cereals, legumes, ornamentals</td>
<td>21,657</td>
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<tr>
<td>ESP007</td>
<td>CSIC - Est. Exp. Aula Dei (Zaragoza)</td>
<td>Cereals (maize, barley), apple, Prunus</td>
<td>1,317</td>
</tr>
<tr>
<td>ESP009</td>
<td>CSIC - Misión Biológica de Galicia (Pontevedra)</td>
<td>Legumes (bean, pea), maize, brassicas</td>
<td>2,103</td>
</tr>
<tr>
<td>ESP010</td>
<td>CIA Finca La Orden - Valdesesquera (Badajoz)</td>
<td>Forage, lupine, fig tree, cherry tree</td>
<td>8,553</td>
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<tr>
<td>ESP014</td>
<td>IRTA - Centro Mas de Bover (Tarragona)</td>
<td>Fruit trees</td>
<td>600</td>
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<tr>
<td>ESP016</td>
<td>NEIKER - Arkaute (Alava)</td>
<td>Bean</td>
<td>294</td>
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<tr>
<td>ESP025</td>
<td>IVIA - Moncada (Valencia)</td>
<td>Citrus</td>
<td>585</td>
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<td>ESP026</td>
<td>Univ. Pol. Valencia - COMAV</td>
<td>Vegetables</td>
<td>8,872</td>
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<td>ESP027</td>
<td>CITA - Banco Germoplasma Hortícolas (Zaragoza)</td>
<td>Vegetables</td>
<td>6,918</td>
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<td>ESP031</td>
<td>C. Inv. e Inf. Ambiental Lourizán (Pontevedra)</td>
<td>Chestnut</td>
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<td>ESP032</td>
<td>SERIDA - Villaviciosa (Asturias)</td>
<td>Bean, wheat, apple, hazel</td>
<td>969</td>
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<tr>
<td>ESP046</td>
<td>IFAPA - Alameda del Obispo (Córdoba)</td>
<td>Fava bean, chickpea, olive tree, garlic</td>
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<td>ESP048</td>
<td>ICIA - Valle de Guerra (Tenerife)</td>
<td>Tropical trees</td>
<td>246</td>
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<tr>
<td>ESP058</td>
<td>CSIC - Est. Exp. La Mayora (Málaga)</td>
<td>Vegetables, cherimoya</td>
<td>2,046</td>
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<td>ESP074</td>
<td>IFAPA - Centro Rancho de la Merced (Cádiz)</td>
<td>Vitis</td>
<td>1,010</td>
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<tr>
<td>ESP080</td>
<td>IMIDRA - Banco de Germoplasma de Vid (Madrid)</td>
<td>Vitis</td>
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<tr>
<td>ESP089</td>
<td>Univ. de Lleida - ETS Ingeniería Agraria</td>
<td>Fruit trees</td>
<td>284</td>
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<td>ESP103</td>
<td>Univ. de Oviedo</td>
<td>Forages</td>
<td>43</td>
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<tr>
<td>ESP109</td>
<td>ITA - Finca Zamadueñas (Valladolid)</td>
<td>Legumes, barley, aromatic &amp; medicinal</td>
<td>1,999</td>
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<tr>
<td>ESP110</td>
<td>CITA - Fruticultura (Zaragoza)</td>
<td>Fruit trees</td>
<td>681</td>
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<tr>
<td>ESP119</td>
<td>CIA Mabegondo (A Coruña)</td>
<td>Maize, apple, pear, forages</td>
<td>1,028</td>
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<tr>
<td>ESP124</td>
<td>CIA Albaladejito (Cuenca)</td>
<td>Lentil, saffron crocus</td>
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<td>ESP133</td>
<td>IMIDA - La Alberca (Murcia)</td>
<td>Fruit trees</td>
<td>854</td>
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<td>ESP138</td>
<td>IFAPA - Centro de Churriana (Málaga)</td>
<td>Strawberry</td>
<td>432</td>
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<tr>
<td>ESP145</td>
<td>IFAPA- Centro La Mojonera (Almería)</td>
<td>Aromatic &amp; medicinal plants</td>
<td>173</td>
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<tr>
<td>ESP149</td>
<td>CITA - Recursos Forestales (Zaragoza)</td>
<td>Aromatic &amp; medicinal plants</td>
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<tr>
<td>ESP160</td>
<td>Univ. Miguel Hernández de Elche (Alicante)</td>
<td>Quince</td>
<td>502</td>
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<td>ESP172</td>
<td>Centro de Conserv. Biodiv. Agrícola de Tenerife</td>
<td>Multi crops</td>
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<tr>
<td>ESP197</td>
<td>Univ. Pública de Navarra - ETSI Agrónomos</td>
<td>Apple</td>
<td>655</td>
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<td>ESP198</td>
<td>IMIDRA - Banco de Variedades Locales (Madrid)</td>
<td>Bean, vegetables</td>
<td>135</td>
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<td>ESP200</td>
<td>IRFAP (Baleares)</td>
<td>Fig tree, vegetables, grapevine</td>
<td>463</td>
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<tr>
<td>ESP214</td>
<td>ETSIA Univ. Sevilla</td>
<td>Fruit trees (Prunus)</td>
<td>28</td>
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<tr>
<td>ESP216</td>
<td>IVICAM-Ins Vid y Vino Castilla-La Mancha</td>
<td>Vitis</td>
<td>306</td>
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<tr>
<td>ESP218</td>
<td>Jardín Botánico CLM</td>
<td>Aromatic &amp; medicinal plants</td>
<td>100</td>
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</tbody>
</table>
With regard to collection size (Fig. 2), CRF holds the largest collection with 21,957 accessions, which is more than twice the number of accessions of the second largest collection. It should be noted here that the genetic base of the species is a relevant factor and that important collections like the IFAPA Olive genebank can appropriately contain the worldwide genetic diversity of the species in a moderate number of accessions. Also, the specific management and land requirements of field collections make the conservation of a great number of accessions unfeasible.

Figure 2. - Number of accessions held by each genebank, by crop group.

The germplasm collections of the Spanish Network hold a great taxonomic diversity: 3,924 species of 1,011 genera. However, the most represented 100 species account for the 80% of the total accessions. The conservation of autochthonous germplasm has been a priority for the National Programme, and consequently Spain is the origin country of most of the conserved accessions (69%), although the National Inventory includes germplasm of 143 countries. Portugal is the second most represented country (Fig. 3). Many accessions of foreign origin, which are actually duplicates from other genebanks, were incorporated to the CRF collections soon after its establishment.

The fast replacement of the diversity of traditional varieties by improved varieties that took place in the Spanish crop fields throughout the 20th century made the collection of traditional varieties a priority. For this reason, these materials represent more than half of the conserved accessions (51%). The genetic erosion of wild species has also been taken into consideration, and recently the interest in the conservation of crop wild relatives has increased. Thus, wild species account for 29% of the total accessions. Finally, the 4% of improved varieties represented in the National Inventory include varieties cancelled from the national register of commercial varieties (Fig. 4).
Fig. 3. - Origin countries of the germplasm conserved in the National Network, as a percentage of the total number of accessions. ESP = Spain; PRT = Portugal.

The most represented crop groups in the National Inventory in terms of size of the collections are vegetables and grain legumes, followed by winter cereals, forages and wild species (Fig. 5).
2. Main developments of the National Inventory in the last years

In the last years, the CRF has made significant efforts to improve and increase the documentation of the plant germplasm conserved in the National Network. The information of collections not yet documented was incorporated into the National Inventory, and the already existing information was reviewed and updated. Overall, there has been a 25.6% increase in the number of accessions of the National Inventory between April 2009 and April 2014, although it should be noted that in some cases the information review involved the deletion of records. In fact, although most groups have increased during this period, the number of the spring cereals group is now lower. Vegetables is the group with the largest increase due to two particular facts: the inclusion of information of germplasm conserved in different genebanks and the information of new materials collected by CRF, since most of the accessions obtained from collecting activities during this period belong to this group (Fig. 6).
Fig. 6. - Changes in the number of accessions of the National Inventory between 2009 (blue) and 2014 (green), by crop group.
The most relevant work carried out on information inclusion and review in the National Inventory is presented in Table 2.

**Table 2.** - Activities on information inclusion and review in the National Inventory, per year between 2009 and 2014.

<table>
<thead>
<tr>
<th>NEW INFORMATION INCLUSION</th>
<th>INFORMATION REVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009</strong> CRF expedition in Jaén, Olives of IFAPA, Cherry trees of SIA –La Orden, cancelled varieties of bean and pea, Poplar of CITA and Aromatic &amp; medicinal plants of Albadalejito</td>
<td>Prunus of CITA and de EEAD, CCBAT and d CIA collections, Wild species of ETSIA, Corn of CIAM y Forage of La Orden</td>
</tr>
<tr>
<td><strong>2010</strong> CRF expedition in Asturias, Vitis of IMIDRA, Fig trees of SIA-LA Orden, cancelled varieties of oats, barley, <em>Triticum</em> and <em>Triticale</em>, Medicago of IAS-CSIC, Bitter vetch and cock’s head of IFAPA, Aromatic &amp; medicinal plants Albaladejito and Beans of MBG-CSIC</td>
<td></td>
</tr>
<tr>
<td><strong>2011</strong> CRF expedition in Orense, Prunus of CITA, IMIDA and EEAD, Palm trees of UHM, cancelled varieties of eggplant, zucchini, vetch, lettuce, lentils and rice, Vegetables of IRFAP, Potatos of NEIKER, kaki and medlar of IVIA, J.B. de la Orotava collections, Garlics of IFAPA, <em>Lupinus</em> y forage of La Orden, Barley core collection of EEAD, Fig tree and Vitis collection of IRFAP and <em>Crocos</em> of Albadalejito</td>
<td>Apples of 5 gene banks, Prunus of 10 gene banks, Sunflower of IAS, Vegetables of COMAV and CITA and Corn of CIAM, MBG and EEAD</td>
</tr>
<tr>
<td><strong>2012</strong> CRF expedition in Lugo, Pomegranate tree of UMH, Poplars of CITA and cancelled varieties of fava beans and bitter vetch</td>
<td>Brassicas of MBG and Melons and tomatos of La Mayora</td>
</tr>
<tr>
<td><strong>2013</strong> CRF expedition in La Coruña, Forage of La Orden, Apples of UPN, Vitis collection of UPN, Beans of ESAB, Vegetables of CITA and <em>Aegilops</em> CRF expedition</td>
<td></td>
</tr>
<tr>
<td><strong>2014</strong> Vegetables of CITA, Forage of La Orden, Castor oil plant of IMIDA, <em>Vitis</em> of IVICAM and Aromatics of JBCLM</td>
<td>Cucumber of CITA and COMAV and Vitis of several gene banks</td>
</tr>
</tbody>
</table>

CRF has also the mandate to regularly provide EURISCO with updated passport information from the National Inventory. The first contribution to EURISCO in 2003 had information on 17,531 accessions, while the latest in April 2014 included 74,982 records.
In addition, CRF has provided information to the European Central Crop Databases and to report to the ECPGR Working Groups. The information made available in the last years is summarized in Table 3.

**Table 3.** - Information from the National Inventory provided from CRF to the European Central Crop Databases in the last years.

<table>
<thead>
<tr>
<th>ECCDB</th>
<th>YEAR</th>
</tr>
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<tbody>
<tr>
<td>Barley</td>
<td>2008</td>
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<tr>
<td><em>Lupinus</em></td>
<td>2008</td>
</tr>
<tr>
<td><em>Vigna</em></td>
<td>2009</td>
</tr>
<tr>
<td><em>Phaseolus</em></td>
<td>2009</td>
</tr>
<tr>
<td>Legumes</td>
<td>2010, 2013</td>
</tr>
<tr>
<td><em>Vicia faba</em></td>
<td>2010</td>
</tr>
<tr>
<td><em>Brassica</em></td>
<td>2010</td>
</tr>
<tr>
<td><em>Prunus</em></td>
<td>2010</td>
</tr>
<tr>
<td><em>Secale</em></td>
<td>2011</td>
</tr>
<tr>
<td><em>Triticale</em></td>
<td>2013</td>
</tr>
</tbody>
</table>

3. **Information on characterization and evaluation**

In spite of the considerable work on characterization and evaluation carried out by a number of Spanish institutions, often involving national and international collaboration, overall, the information produced has problems of standardization and accessibility.

The state of the information on characterization and evaluation developed by Spanish institutions and available on-line is summarized in Table 4.
The website also provides characterization information of the Spanish core collections of barley and beans. The information of the barley core collection available includes the results obtained from the characterization of 175 varieties through 28 agro-morphological traits and 5 disease resistance traits. With regard to the 202 varieties of the beans core collection, there is information on 28 agro-morphological traits, 12 cooking and sensorial traits and 7 disease resistance traits.
Neiker Tecnalia, Basque Institute for Agricultural Research and Development (ESP016)
http://www.neiker.net/neiker/germoplasma

<table>
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<th></th>
<th>Agro-morphological charac.</th>
<th>Biochemical charac.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No. of descriptors</td>
<td>No. of records</td>
</tr>
<tr>
<td>Phaseolus vulgaris</td>
<td>20</td>
<td>127</td>
</tr>
<tr>
<td>Solanum lycopersicum*</td>
<td>14</td>
<td>94</td>
</tr>
<tr>
<td>Solanum tuberosum</td>
<td>28</td>
<td>71</td>
</tr>
</tbody>
</table>

The website also provides information on biochemical and culinary characterization of 308 potato varieties (2 and 3 descriptors, respectively) and evaluation information on resistance to 12 diseases.

Balearic Institute for Agricultural and Fish Research and Training (ESP200)

<table>
<thead>
<tr>
<th></th>
<th>Agro-morph. charac.</th>
<th>Biochemical charac.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No. of descriptors</td>
<td>No. of records</td>
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<tr>
<td>Prunus domestica*</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>Malus domestica*</td>
<td>39</td>
<td>17</td>
</tr>
</tbody>
</table>

* PDF file

It is worth mentioning also the website recently developed by the Madrid Institute for Rural, Agricultural and Food Research and Development (ESP080) on their vineyard collection (http://www.madrid.org/coleccionvidencin/) which provides significant characterization information of a not determined number of varieties, rootstocks and wild plants.

Together with all this information, a huge amount of information has been produced and published as paper documentation but not made available online. In order to facilitate the access to the non-online information, and as a way to facilitate access to information by users, the National Inventory website (http://wwwx.inia.es/webcrf/) provides also information on scientific publications, available in the section “Publicaciones”.

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<table>
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<tr>
<th>AUTORES</th>
<th>Año</th>
<th>Título</th>
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<tbody>
<tr>
<td>Asociación Española de la Rosa</td>
<td>1999</td>
<td>1er Catálogo de variedades de rosas españolas. Separata nº 6</td>
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<tr>
<td>Cabello F, De Andrés MT, et al.</td>
<td>2001</td>
<td>Variedades de la vid en la Comunidad de Madrid</td>
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<td>García-Luján A, Lara-Benitez M.</td>
<td>1997</td>
<td>La colección de vides del Rancho de la Merced</td>
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<td>Morera E, Afonso-Morales D</td>
<td>2012</td>
<td>Variedades Agrícolas Tradicionales de Tenerife y La Palma.</td>
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<td>Afonso-Morales D</td>
<td>2012</td>
<td>Variedades locales de trigo de Canarias</td>
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<td>Carravedo M</td>
<td>2006</td>
<td>Variedades autóctonas de Arvejón</td>
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<td>Carravedo M, Mallor C</td>
<td>2008</td>
<td>Variedades autóctonas de lechugas españolas conservadas en el BGHZ</td>
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<td>Carravedo M, Ruiz de Galaretta JI</td>
<td>2005</td>
<td>Variedades autóctonas de tomate del País Vasco, Colección Lur nº 7</td>
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<td>Castell V, Díez MJ</td>
<td>2000</td>
<td>Colección de semillas de cebolla del Centro de Conservación y Mejora de la Agrodiversidad Valenciana</td>
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<tr>
<td>De la Rosa L, Martín I, et al.</td>
<td>2000</td>
<td>La colección de Lathyrus del Centro de Recursos Fitogenéticos</td>
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<tr>
<td>De Sebastián Palomares JI</td>
<td>2008</td>
<td>Frutos secos en Cantabria: La nuez y la avellana.</td>
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<tr>
<td>Díaz Hernández MB, Ramos-Cabrero AM, et al.</td>
<td>2007</td>
<td>Estudio comparativo de los principales cultivares de manzano (Malus x domestica) de Asturias. País Vasco y Galicia</td>
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<td>Gadea M</td>
<td>1954</td>
<td>Triquis españoles</td>
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<td>García-Ménez E, Ruiz de Galaretta JI, et al.</td>
<td>2013</td>
<td>Variedades locales de maiz de Cantabria</td>
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<td>Lasa JM</td>
<td>2008</td>
<td>Spanish Barley Core Collection</td>
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<td>Lázaro A. Cortes I, et al.</td>
<td>2012</td>
<td>Catálogo de variedades de melón tradicionales españolas</td>
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<tr>
<td>Lorenzo R, Gil- González J</td>
<td>2007</td>
<td>Los cultivos tradicionales y su diversidad. Boniatos de la isla de La Palma. Inventario e identificación</td>
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<td>Martínez-Calvo J, Badenes ML, et al.</td>
<td>2006</td>
<td>Descripción de nuevas variedades de níspero japonés del Banco de Germoplasma del IVIA</td>
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<td>Martínez-Calvo J, Badenes ML, et al.</td>
<td>2008</td>
<td>Descripción de 35 nuevas variedades de níspero japonés del Banco de Germoplasma del IVIA</td>
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<td>Moreno J, Trujillo- Navas I</td>
<td>2006</td>
<td>Variedades tradicionales de cerezo (Prunus avium L.) del Valle del Jerte: prospección, caracterización e identificación morfológica y molecular</td>
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<td>Nuez F, Díez MJ, et al.</td>
<td>1998</td>
<td>Catálogo de semillas de pimiento</td>
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<td>Nuez F, Gómez- Campo C., et al.</td>
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<td>Colección de semillas de coliflor y bróculi</td>
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<td>Nuez F, Leiva-Bronco M, et al.</td>
<td>2002</td>
<td>Colección de semillas de aceituna del Centro de Conservación y Mejora de la Agrodiversidad Valenciana</td>
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<td>Nuez F, Prohens J, et al.</td>
<td>2002</td>
<td>Colección de semillas de berenjena del centro de conservación y mejora de la Agrodiversidad Valenciana</td>
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<td>Nuez F, Ruiz JJ, et al.</td>
<td>2000</td>
<td>Colección de semillas de calabaza del Centro de Conservación y Mejora de la Agrodiversidad Valenciana</td>
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<td>Nuez F, Soler S, et al.</td>
<td>2002</td>
<td>Colección de semillas de col-repollo del Centro de Conservación y Mejora de la Agrodiversidad Valenciana</td>
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<td>Nuez F, Valcárcel JIV, et al.</td>
<td>2000</td>
<td>Colección de semillas de otras especies hortícolas del Centro de Conservación y Mejora de la Agrodiversidad Valenciana</td>
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<tr>
<td>Ocete R, López-Martínez MA, et al.</td>
<td>1999</td>
<td>Las poblaciones esasoflas de vid silvestre</td>
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<td>Oliveira JA</td>
<td>2006</td>
<td>Conservación y utilización de recursos fitogenéticos de gramíneas prateses</td>
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<tr>
<td>Pereira S, Acesibar J., et al.</td>
<td>2002</td>
<td>Colección de cultivares autóctonos gallegos de manzano del banco de germoplasma de Mabezone</td>
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<tr>
<td>Pereira S, Ramos-Cabrero AM</td>
<td>2005</td>
<td>Características morfológicas e isoenzimáticas de los cultivares de Castaño (Castanea sativa Mill.) de Andalucía</td>
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<td>Pereira S, Ramos-Cabrero AM, et al.</td>
<td>2005</td>
<td>Características morfológicas e isoenzimáticas de los cultivares de castaño (Castanea sativa Mill.) de Asturias</td>
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<tr>
<td>Ponz R, De la Rosa L, et al.</td>
<td>1992</td>
<td>Evaluación de germoplasma de garbanzos</td>
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<tr>
<td>Ponz R, De la Rosa L, et al.</td>
<td>1992</td>
<td>Evaluación de germoplasma de lentejas</td>
</tr>
<tr>
<td>Ramos-Cabrño AM, Pereira-Tabaoda A, et al.</td>
<td>2003</td>
<td>Características morfológicas e isoenzimáticas de los principales cultivares de castaño Castanea sativa Mill. de El Bierzo y Guadalupe</td>
</tr>
<tr>
<td>Tascón C, Rodríguez-Galdón B</td>
<td>2012</td>
<td>Las cebollas de Tenerife. Cultivo y variedades</td>
</tr>
<tr>
<td>Tellez -Molina R, Alonso Peña M</td>
<td>1952</td>
<td>Los trigos de la Ceres Hispanica</td>
</tr>
</tbody>
</table>

**Tabla 5.** Referencias de literatura gris incluyendo caracterización y evaluación de datos de colecciones españolas.
4. Next steps

- The compilation and integration of passport information from the collections of the Spanish Network into the National Inventory will continue in the future as long as the collections grow (or decrease) in number of accessions and their associated information is updated. Raising the quality levels of the information of the National Inventory will still need to be a priority in order to facilitate access to the germplasm by users, especially when the information of the NI is available not only through the INIA website but also in international databases like EURISCO and GENESYS.

- The publication of existing and new characterization and evaluation information in online platforms remains a challenge because of the human and financial resources required for the standardization of information when collections have a considerable size and various working teams are involved.

- It will be necessary to link the documentation of ex situ plant germplasm collections with other information related to plant genetic resources conservation, like inventories of crop wild relatives, lists of landraces covered by on-farm conservation actions, and others. In Spain these areas are at an early stage, and strong and multidisciplinary partnerships will be necessary for their further development.