

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 loss. 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).

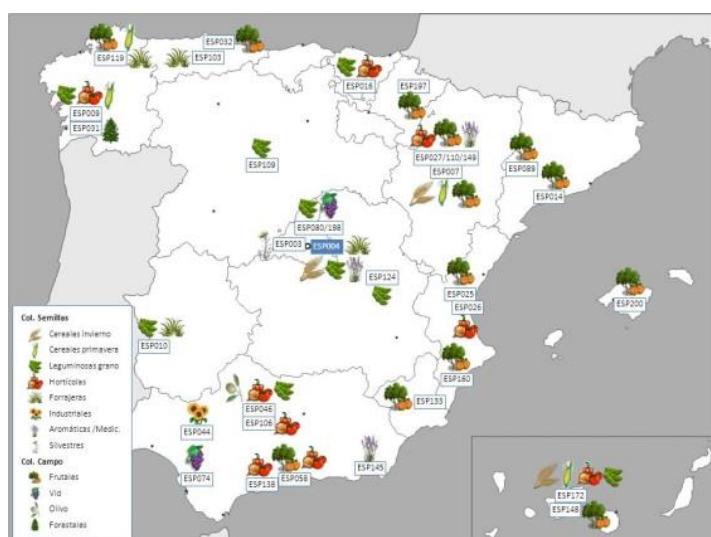


Fig. 1. - Map of the 35 institutions participating to the National Network of *ex situ* PGRFA collections.

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-line¹, 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://www.inia.es/webcrf>

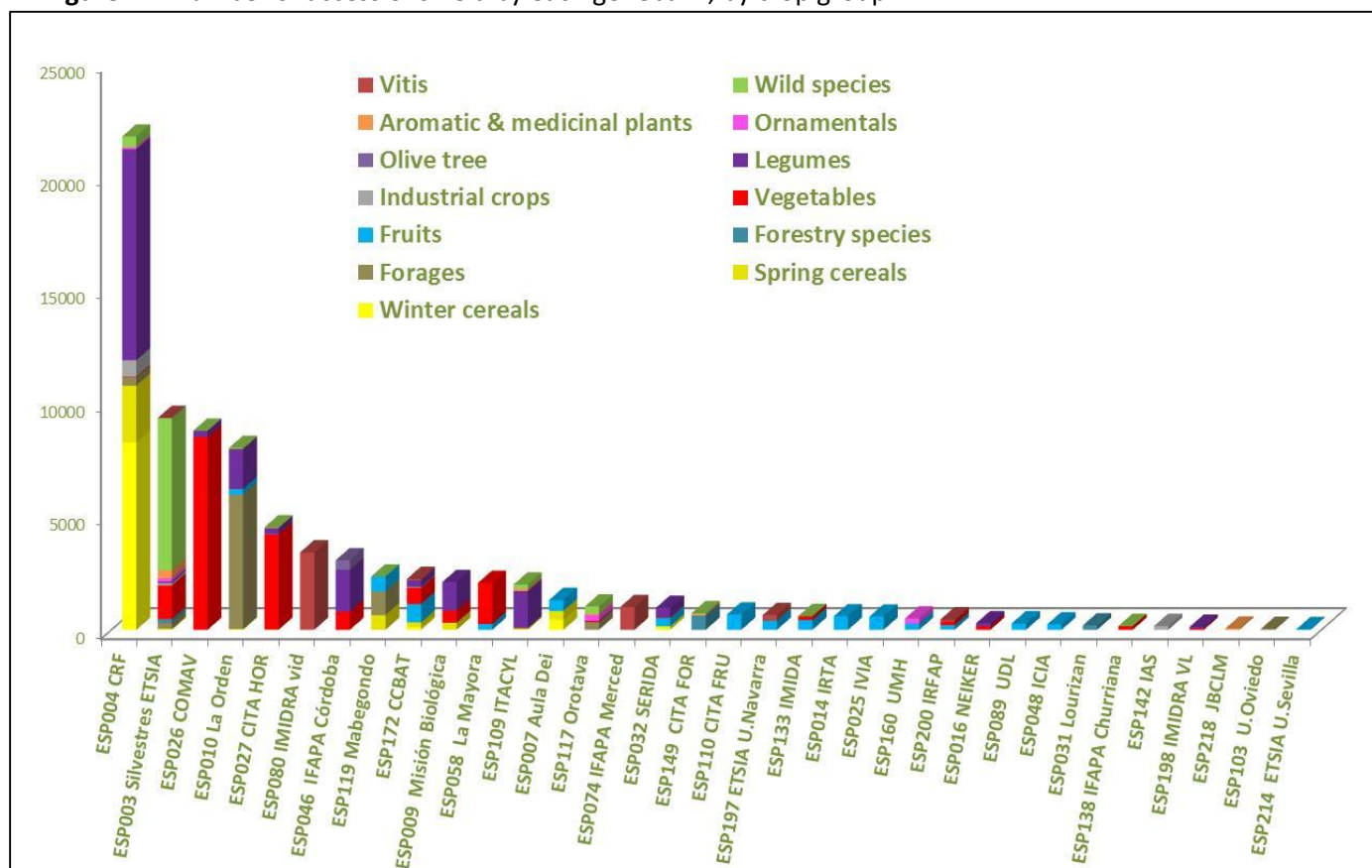
IFAPA as well as the IMIDRA *Vitis* collection in Madrid. Given the economic importance of vineyard in Spain, a project aimed at gathering and analyzing the information on the germplasm conserved in a number of institutions is currently underway. In the group of vegetable species, the COMAV genebank 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

FAO CODE	INSTITUTION	MAIN COLLECTIONS	Accessions
ESP003	U. P. Madrid - Banco de Germoplasma Vegetal	Wild species, crucifers	9,218
ESP004	INIA - Centro Nacional de Recursos Fitogenéticos	Cereals, legumes, ornamentals	21,657
ESP007	CSIC - Est. Exp. Aula Dei (Zaragoza)	Cereals (maize, barley), apple, <i>Prunus</i>	1,317
ESP009	CSIC - Misión Biológica de Galicia (Pontevedra)	Legumes (bean, pea), maize, brassicas	2,103
ESP010	CIA Finca La Orden - Valdesequera (Badajoz)	Forage, lupine, fig tree, cherry tree	8,553
ESP014	IRTA - Centro Mas de Bover (Tarragona)	Fruit trees	600
ESP016	NEIKER - Arkaute (Alava)	Bean	294
ESP025	IVIA - Moncada (Valencia)	<i>Citrus</i>	585
ESP026	Univ. Pol. Valencia - COMAV	Vegetables	8,872
ESP027	CITA - Banco Germoplasma Hortícolas (Zaragoza)	Vegetables	6,918
ESP031	C. Inv. e Inf. Ambiental Lourizán (Pontevedra)	Chestnut	199
ESP032	SERIDA - Villaviciosa (Asturias)	Bean, wheat, apple, hazel	969
ESP046	IFAPA - Alameda del Obispo (Córdoba)	Fava bean, chickpea, olive tree, garlic	3,076
ESP048	ICIA - Valle de Guerra (Tenerife)	Tropical trees	246
ESP058	CSIC - Est. Exp. La Mayora (Málaga)	Vegetables, cherimoya	2,046
ESP074	IFAPA - Centro Rancho de la Merced (Cádiz)	<i>Vitis</i>	1,010
ESP080	IMIDRA - Banco de Germoplasma de Vid (Madrid)	<i>Vitis</i>	3,416
ESP089	Univ. de Lleida - ETS Ingeniería Agraria	Fruit trees	284
ESP103	Univ. de Oviedo	Forages	43
ESP109	ITA - Finca Zamadueñas (Valladolid)	Legumes, barley, aromatic & medicinal	1,999
ESP110	CITA - Fruticultura (Zaragoza)	Fruit trees	681
ESP119	CIA Mabegondo (A Coruña)	Maize, apple, pear, forages	1,028
ESP124	CIA Albaladejito (Cuenca)	Lentil, saffron crocus	2,359
ESP133	IMIDA - La Alberca (Murcia)	Fruit trees	854
ESP138	IFAPA - Centro de Churriana (Málaga)	Strawberry	432
ESP145	IFAPA- Centro La Mojonera (Almería)	Aromatic & medicinal plants	173
ESP149	CITA - Recursos Forestales (Zaragoza)	Aromatic & medicinal plants	733
ESP160	Univ. Miguel Hernández de Elche (Alicante)	Quince	502
ESP172	Centro de Conserv. Biodiv. Agrícola de Tenerife	Multi crops	2,256
ESP197	Univ. Pública de Navarra - ETSI Agrónomos	Apple	655
ESP198	IMIDRA - Banco de Variedades Locales (Madrid)	Bean, vegetables	135
ESP200	IRFAP (Balears)	Fig tree, vegetables, grapevine	463
ESP214	ETSIA Univ. Sevilla	Fruit trees (<i>Prunus</i>)	28
ESP216	IVICAM-Ins Vid y Vino Castilla-La Mancha	<i>Vitis</i>	306
ESP218	Jardín Botánico CLM	Aromatic & medicinal plants	100

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.

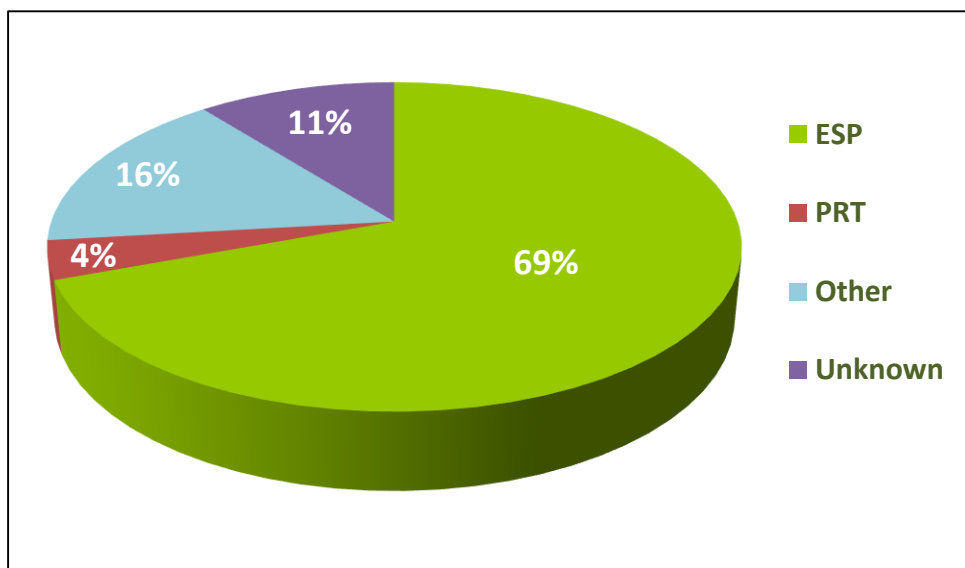
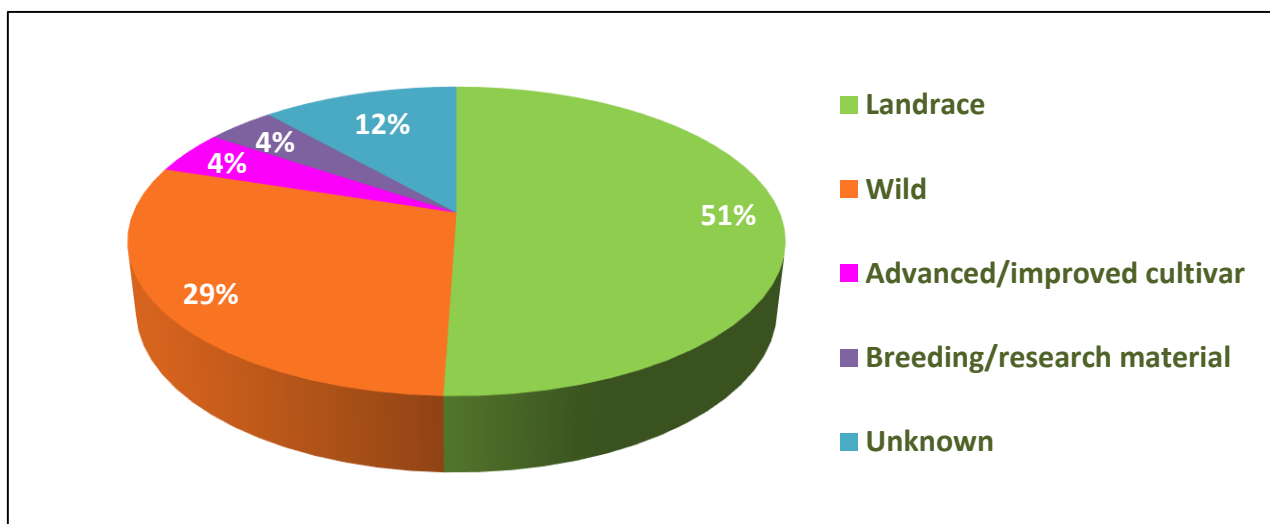
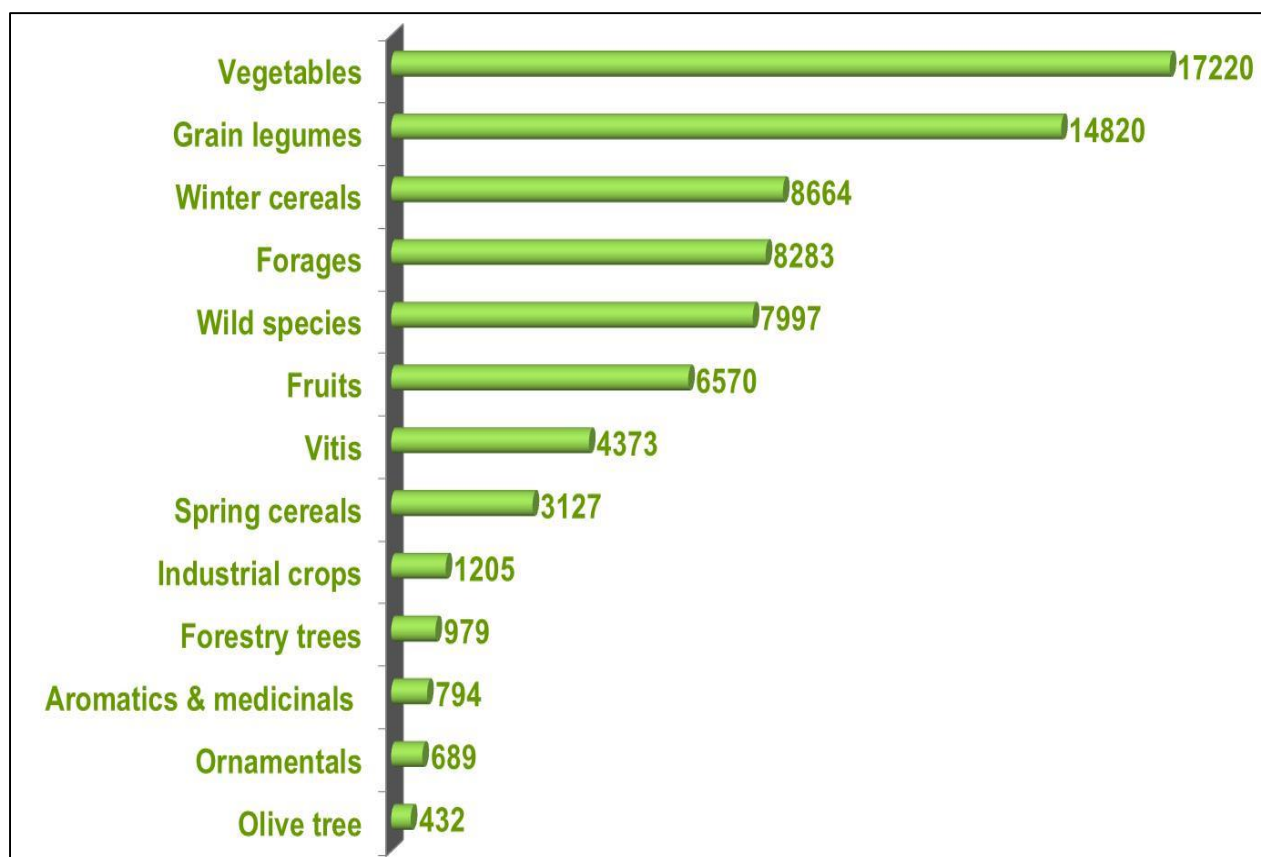


Fig. 4. - Type of materials conserved in the National Network, as a percentage of the total number of accessions.



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).

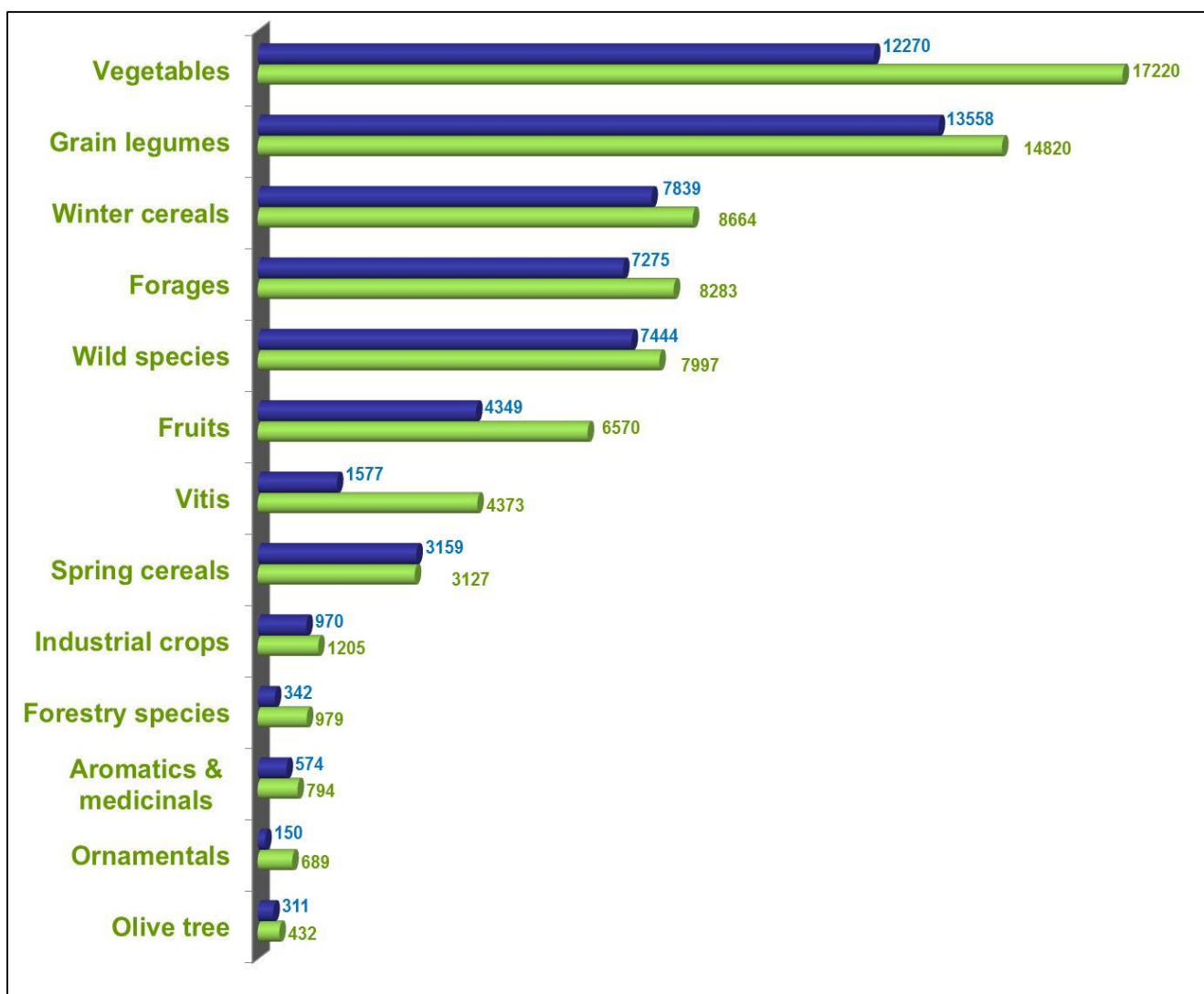
Fig. 5. - Number of accessions maintained by the National Network, by crop group.



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.

	NEW INFORMATION INCLUSION	INFORMATION REVIEW
2009	CRF expedition in Jaén, Olives of IFAPA, Cherry trees of SIA –La Orden, cancelled varieties of bean and pea, Poplar of CITA and Aromatic & medicinal plants of Albadalejito	
2010	CRF expedition in Asturias, Vitis of IMIDRA, Fig trees of SIA-LA Orden, cancelled varieties of oats, barley, <i>Triticum</i> and <i>Triticale</i> , <i>Medicago</i> of IAS-CSIC, Bitter vetch and cock's head of IFAPA, Aromatic & medicinal plants Albaladejito and Beans of MBG-CSIC	<i>Prunus</i> of CITA and de EEAD, CCBAT and CIA collections, Wild species of ETSIA, Corn of CIAM y Forage of La Orden
2011	CRF expedition in Orense, <i>Prunus</i> 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, <i>Lupinus</i> y forage of La Orden, Barley core collection of EEAD, Fig tree and <i>Vitis</i> collection of IRFAP and <i>Crocus</i> of Albadalejito	Apples of 5 gene banks, <i>Prunus</i> of 10 gene banks, Sunflower of IAS, Vegetables of COMAV and CITA and Corn of CIAM, MBG and EEAD
2012	CRF expedition in Lugo, Pomegranate tree of UMH, Poplars of CITA and cancelled varieties of fava beans and bitter vetch	Brassicas of MBG and Melons and tomatos of La Mayora
2013	CRF expedition in La Coruña, Forage of LA Orden, Apples of UPN, <i>Vitis</i> collection of UPN, Beans of ESAB, Vegetables of CITA and <i>Aegilops</i> CRF expedition	
2014	Vegetables of CITA, Forage of La Orden, Castor oil plant of IMIDA, <i>Vitis</i> of IVICAM and Aromatics of JBCLM	Cucumber of CITA and COMAV and <i>Vitis</i> of several gene banks

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.

ECCDB	YEAR
Barley	2008
Lupinus	2008
Wheat	2008, 2011 and 2012
Vigna	2009
Phaseolus	2009
Legumes	2010, 2013
Vicia faba	2010
Brassica	2010
Prunus	2010
Secale	2011
Triticale	2013

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.

Table 4. - Information on characterization and evaluation available on-line, by institution

National Centre for Plant Genetic Resources, INIA (ESP004)						
http://wwwsp.inia.es/Investigacion/centros/crf/Paginas/CRF.aspx						
	Agro-morph. charac.		Biochemical charac.		Disease resistances	
	No. of descriptors	No. of records	No. of descriptors	No. of records	No. of descriptors	No. of records
CEREALS						
<i>Avena byzantina</i>	19	59			1	8
<i>Avena sativa</i>	20	527			1	159
<i>Avena strigosa</i>	20	19				
<i>Hordeum vulgare</i>	22	460				
<i>Secale cereale</i>	8	99				
<i>Triticum aestivum</i>	14	1105				
<i>Triticum monococcum</i>	17	53				
<i>Triticum timopheevi</i>	14	3				
<i>Triticum turgidum</i>	14	812				
<i>Zea mays</i>	12	1207				
LEGUMES						
<i>Lathyrus cicera</i>	23	168				
<i>Lathyrus sativus</i>	19	60				
<i>Lens culinaris</i>	17	230				
<i>Phaseolus vulgaris</i>					6	467
<i>Pisum sativum</i>	23	277				
<i>Vicia articulata</i>	14	78	1	78		
<i>Vicia ervilia</i>	25	165				
<i>Vicia sativa</i>	41	494				
AROMATICS						
<i>Hypericum sp.</i>			7	76		
<i>Thymus mastichina</i>			11	52		
<i>Thymus vulgaris</i>			8	64		
<i>Thymus zygis</i>			16	55		
OTHERS						
<i>Solanum lycopersicum</i>	4	57	1	57		

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>

	Agro-morphological charac.	
	No. of descriptors	No. of records
<i>Phaseolus vulgaris</i>	20	127
<i>Solanum lycopersicum</i> *	14	94
<i>Solanum tuberosum</i>	28	71

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)

<http://www.caib.es/sacmicrofront/contenido.do?mkey=M65&lang=ES&cont=2031>

	Agro-morph. charac.		Biochemical charac.	
	No. of descriptors	No. of records	No. of descriptors	No. of records
<i>Prunus domestica</i> *	30	18	3	18
<i>Malus domestica</i> *	39	17	3	17

* 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".

Table 5. - References of grey literature including characterization and evaluation data of Spanish collections.

AUTHORS	YEAR	TITLE
Asociación Española de la Rosa	1999	1er Catálogo de variedades de rosas españolas. Separata nº 6
Cabello F. De Andrés MT. <i>et al.</i>	2001	Variedades de la vid en la Comunidad de Madrid
García-Luián A. Lara-Benitez M.	1997	La colección de vides del Rancho de la Merced
Chomé P. López-Corrales M. <i>et al.</i>	2011	Variedades de Higuera. Descripción v registro de variedades.
Cabello F. Ortiz J. <i>et al.</i>	2011	Variedades de Vid en España.
Chomé P. Zaragoza S <i>et al.</i>	2011	Las variedades de Cítricos. El material vegetal v el registro de variedades comerciales de España.
Morera E, Afonso-Morales D	2012	Variedades Agrícolas Tradicionales de Tenerife v La Palma.
Afonso-Morales D.	2012	Variedades locales de trigo de Canarias
Cabello F. Rodríguez-Torres I. <i>et al.</i>	2003	La colección de variedades de vid de "El Encín". Un recorrido por la Historia de la Ampelografía
Carravedo M. Ochoa MJ. <i>et al.</i>	2005	Catálogo Genético de Pimientos Autóctonos. (Banco de Germoplasma Especies Hortícolas. Zaragoza).
Carravedo M. Mallor C	2007	Variedades autóctonas de cebollas españolas. (Banco de Germoplasma de Especies Hortícolas. Zaragoza).
Carravedo M	2006	Variedades autóctonas de tomates de Aragón
Carravedo M, Mallor C	2008	Variedades autóctonas de legumbres españolas conservadas en el BGHZ
Carravedo M. Ruiz de Galarreta JI	2005	Variedades autóctonas de tomate del País Vasco. Colección Lur nº 7
Castell V. Díez MJ	2000	Colección de semillas de cebolla del Centro de Conservación v Meiora de la Agrobiodiversidad Valenciana
De la Cuadra C. De Ron AM. <i>et al.</i>	2001	Phaseleu. Handbook on evaluation of <i>Phaseolus</i> germoplasm
De la Rosa L. Martín I. <i>et al.</i>	2000	La colección de <i>Lathyrus</i> del Centro de Recursos Fito genéticos
De Sebastián Palomares JI	2008	Frutos secos en Cantabria: La nuez v la avellana.
Del Valle-Alburquerque M. Yuste JR. <i>et al.</i>	2006	Descripción v caracterización agronómica de 28 variedades tintas de Vid. en Castilla v León.
Díaz Hernández MB. Ramos-Cabrer AM. <i>et al.</i>	2007	Estudio comparativo de los principales cultivares de manzano (<i>Malus x domestica</i>) de Asturias. País Vasco v Galicia
Gadea M	1954	Trigos españoles
García-Ménez E. Ruiz de Galarreta JI. <i>et al.</i>	2013	Variedades locales de maíz de Cantabria
González-Rodríguez AM. Grajal- Martín MJ	2011	Higueras de Canarias. Caracterización morfológica de variedades.
Gutiérrez-Claramunt M. Mallavia-Alcalde H	2004	Alubias autóctonas en Cantabria: "El Carico Montañés". (<i>Phaseolus vulgaris</i> L.. Vr. "Carico").
Lasa JM	2008	Spanish Barley Core Collection
Lázaro A. Cortes I. <i>et al.</i>	2012	Catálogo de variedades de melón tradicionales españolas
Leonardo LJ. Amador L. <i>et al.</i>	2012	Variedades tradicionales de tomates de Canarias
Lorenzo R. Gil- González J	2007	Los cultivos tradicionales v su diversidad. Boniatos de la isla de La Palma. Inventario e identificación
Martínez-Calvo J, Badenes ML. <i>et al.</i>	2006	Descripción de nuevas variedades de níspero japonés del Banco de Germoplasma del IVIA
Martínez-Calvo J, Badenes ML. <i>et al.</i>	2008	Descripción de 35 nuevas variedades de níspero japonés del Banco de Germoplasma del IVIA
Moreno J. Truiillo- Navas I	2006	Variedades tradicionales de cerezo (<i>Prunus avium</i> L.) del Valle del Jerte: prospección, caracterización e identificación morfológica v molecular
Moreno -Valencia MM. Meco-Murillo R. <i>et al.</i>	2010	Tomates tradicionales de Castilla La Mancha.
Nuez F. Díez MJ. <i>et al.</i>	1996	Catálogo de semillas de tomate
Nuez F. Díez MJ. <i>et al.</i>	1998	Catálogo de semillas de pimiento
Nuez F. Fernández de Córdoba P. <i>et al.</i>	2000	Colección de semillas de lechuga del Centro de Conservación v Meiora de la Agrobiodiversidad Valenciana
Nuez F. Gómez- Campo C. <i>et al.</i>	1999	Colección de semillas de coliflor v brócoli
Nuez F. Leiva-Brondo M. <i>et al.</i>	2002	Colección de semillas de acelea del Centro de Conservación v Meiora de la Agrobiodiversidad Valenciana
Nuez F. Prohens J. <i>et al.</i>	1998	Catálogo de semillas de sandía.
Nuez F. Prohens J. <i>et al.</i>	1996	Catálogo de semillas de melón
Nuez F. Prohens J. <i>et al.</i>	2002	Colección de semillas de berenjena del centro de conservación v meiora de la Agrobiodiversidad Valenciana
Nuez F. Ruiz JJ. <i>et al.</i>	2000	Colección de semillas de calabaza del Centro de Conservación v Meiora de la Agrobiodiversidad Valenciana
Nuez F. Soler S. <i>et al.</i>	2002	Colección de semillas de col-repollo del Centro de Conservación v Meiora de la Agrobiodiversidad Valenciana
Nuez F. Valcárcel JV. <i>et al.</i>	2000	Colección de semillas de otras especies hortícolas del Centro de Conservación v Meiora de la Agrobiodiversidad Valenciana
Ocete R. López-Mártinez MA. <i>et al.</i>	1999	Las poblaciones españolas de vid silvestre
Oliveira JA	2006	Conservación v utilización de recursos fito genéticos de gramíneas pratenses
Pereira S. Fernández -López J	1997	Los cultivares autóctonos de castaño (<i>Castanea sativa</i> Mill.) en Galicia.
Pereira S. Ascasibar J. <i>et al.</i>	2002	Colección de cultivares autóctonos gallegos de manzano del banco de germoplasma de Mabegondo
Pereira S. Ramos-Cabrer AM	2003	Características morfológicas e isoenzimáticas de los cultivares de Castaño (<i>Castanea sativa</i> Mill.) de Andalucía
Pereira S. Ramos-Cabrer AM. <i>et al.</i>	2005	Características morfológicas e isoenzimáticas de los cultivares de castaño (<i>Castanea sativa</i> Mill.) de Asturias
Pereira S. Carregosa A. <i>et al.</i>	2013	Caracterización. Dos cultivares de pereira do banco de xermoplasma. Do centro de investigacións agrarias de Mabegondo (CIAM)
Ponz R. De la Rosa L. <i>et al.</i>	1992	Evaluación de germoplasma de garbanzos
Ponz R. De la Rosa L. <i>et al.</i>	1992	Evaluación de germoplasma de lentejas
Ramos-Cabrer AM, Pereira-Taboada A. <i>et al.</i>	2003	Características morfológicas e isoenzimáticas de los principales cultivares de castaño <i>Castanea sativa</i> Mill. de El Bierzo v Guadalupe
Tascón C. Rodríguez-Galdón B	2012	Las cebollas de Tenerife. Cultivo v variedades
Tellez -Molina R. Alonso Peña M	1952	Los trigos de la Ceres Hispanica

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.