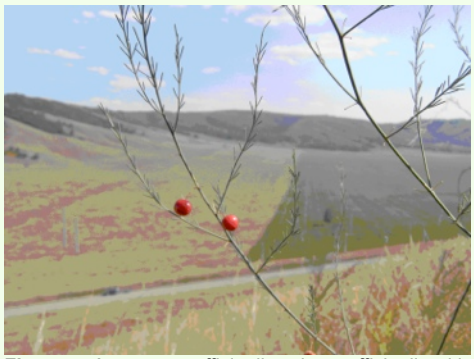

Figure 5 *Asparagus officinalis* subsp. *officinalis* with fruits (Photo: Yulia Kanygina)

tal plant. Young shoots contain a lot of vitamins and microelements. Wild asparagus from *Bashkiria* has the potential to contribute drought resistance to cultivated asparagus. *A. officinalis* can be found in the Park in the steppes, steppe meadows and forest edges.

CWR growing in the National Park *Bashkiria* will be collected and all accessions will be included in the National Genebank of Russia within the partnership agreement between the Park and N. I. Vavilov Institute of Plant Industry.

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Prioritized crop wild relatives in Spain: status on the National Inventory of Plant Genetic Resources for Agriculture and Food

L. De la Rosa[1], E. Aguiriano[1], C. Mallor[2], M.L. Rubio Teso[3], M. Parra Quijano[4], E. Torres[5] and J.M. Iriondo[3]

[1] Centro Nacional de Recursos Fitogenéticos (CRF), INIA. Finca La Canaleja, E-28800 Alcalá de Henares (Madrid), Spain

[2] Centro Investigación y Tecnología Agroalimentaria de Aragón (CITA), Gobierno de Aragón, Avd. de Montañana 930 E-50059 (Zaragoza), Spain

[3] Departamento de Biología y Geología, Área de Biodiversidad y Conservación, Universidad Rey Juan Carlos, C/ Tulipán, s/n. E-28933 Móstoles (Madrid), Spain

[4] The International Treaty on Plant Genetic Resources for Food and Agriculture, Via delle Terme di Caracalla, 00153 Rome, Italy

[5] Departamento de Biología Vegetal, Universidad Politécnica de Madrid, Ciudad Universitaria, Avda. Complutense, s/n. E-28040 (Madrid), Spain

This paper aims to report progress in the prioritization of crop wild relatives (CWR) to be achieved by 2020, with the objective of establishing national conservation action plans, filling *ex situ* conservation gaps and enhancing CWR utilization, as proposed by Maxted and Kell (2012). In order to know the status of the *ex situ* conservation of CWR in Spain, we have reviewed the passport data in the database of the Spanish National Inventory of Plant Genetic Resources for Food and Agriculture (PGRFA NI) of the species included in the crop genera selected in the preparation of the prioritized Spanish CWR checklist in the context of the PGR Secure project (Rubio Teso *et al.*, 2012).

Daucus carota L. (Photo: BGHZ)

In Spain, the collection and the *ex situ* conservation of CWR, together with their *in situ* conservation in protected areas, have been key factors in the preservation of these species, particularly in those cases where the habitat had clearly been disturbed. The best example of this was the reintroduction of *Diplotaxis siettiana* Maire in Alborán Island with germplasm stored in a genebank after the only natural population became extinct (Martínez-Laborde, 1998). Although PGRFA databases have usually been ignored in biodiversity catalogues, national inventories of plant genetic resources provide a good data source that complements those of floristic and vegetation databases (Landucci *et al.*, 2012), helping attain a global view of the status of CWR conservation. Knowledge of the CWR maintained in genebanks and their availability allows the identification of CWR species that are not conserved and is useful for making decisions related to collection and regeneration/multiplication activities. Together with the study of the National Inventory of PGRFA, the quality assessment of georeferenced passport data of the included species will be a good support to prioritize actions in order to efficiently conserve CWR species in Spain as done in other countries (e.g., Magos Brehm *et al.*, 2008; Berlingeri and Crespo, 2012; Idohou *et al.*, 2013). We have mainly used the information from three Spanish genebanks belonging to the National Network of Plant Genetic Resources: the CRF-INIA (National Centre of Plant Genetic Resources), the BGHZ (Vegetables

Table 1 Status of prioritized CWR genera and the prioritized checklist of Spanish National Inventory of PGRFA

Genera	Nº acc. with passport data	Nº species in PGRFA NI	Nº acc. in collection	Nº of prioritized species
Aegilops	527	17	423	5
Allium	179	11	163	3
Apium	7	3	5	1
Asparagus	16	7	15	4
Avena	391	8	330	4
Beta	33	5	26	2
Borago	15	1	15	1
Brassica	784	36	762	7
Capsella	22	3	21	1
Cicer	4	3	4	1
Cichorium	18	1	13	1
Cynara	6	5	4	4
Daucus	24	4	23	1
Diplotaxis	311	27	311	3
Erucastrum	145	16	145	2
Fragaria	42	4	42	0
Hordeum	178	10	146	2
Lactuca	29	20	28	6
Lathyrus	100	13	55	7
Lens	65	3	36	2
Moricandia	83	8	82	1
Patellifolia	1	1	1	1
Pisum	10	2	8	1
Raphanus	87	2	87	1
Secale	5	1	2	1
Sinapis	113	7	113	2
Solanum	549	34	539	2
Vicia	504	22	412	15
Totals	**4248**	**274**	**3811**	**81**

Genebank of Zaragoza) of the Aragón Autonomous Government and the "César Gómez" genebank of the Polytechnic University of Madrid. CRF responsibilities include the conservation of safety duplicates of all Spanish seed collections, the documentation and National Inventory of the network of PGRFA collections under the National Programme and the characterization and evaluation of grain legumes, winter cereals and some industrial crops in active collections. BGHZ is responsible for one of the largest Spanish vegetable active collections, including neglected and underutilized crops. Finally, "César Gómez" Bank holds the largest Spanish collection of wild plant species.

In this study, genera that reproduce by seeds (with the exception of the genus *Fragaria* which is mainly clonally reproduced) and included in the category 'food genera' of Rubio Teso *et al*. (2012) were studied, whereas the remaining vegetatively reproduced crops (*Malus* Mill., *Prunus* L., *Pyrus* L., *Vitis* L. and *Olea* L.) were excluded.

A total of 4248 accessions of CWR species were identified (Table 1) in the Spanish National Inventory of PGRFA. In a first approach the accessions at genus level were analysed (column 1). The number of records by genus in the PGRFA NI passport database is shown in the second column. All prioritized genera are represented in *ex situ* collections, ranging in the number of accessions from one in *Patellifolia* A.J. Scott, Ford-Lloyd & J.T. Williams to 784 in *Brassica* L. The third column shows the number of CWR species by selected genus found in the PGRFA NI. A total of 274 species were identified. The genera *Brassica* L. and *Solanum* L. displayed the greatest diversity with 36 and 34 species, respectively.

In order to perform a more realistic approach to the conservation status of the prioritized CWR, in the fourth column, 'N° acc. in collection', the number of accessions by genus currently preserved in active collections is indicated. The difference between the second and the fourth columns indicates the loss of accessions over time due to poor initial quality seeds or problems in the multiplication process.

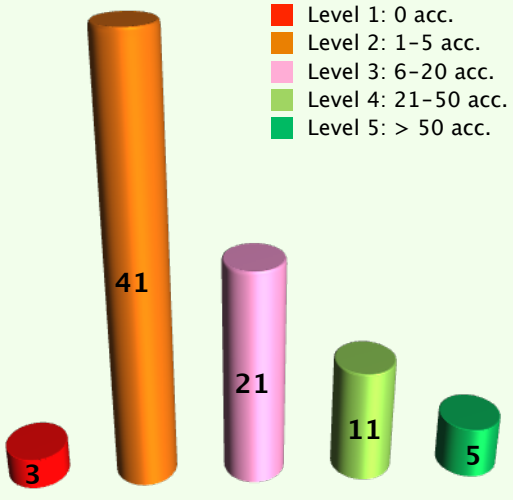

Figure 1 Distribution of PGRFA NI species by number of accessions according to their multiplication/regeneration needs

The initial checklist of CWR of food crops was further used to generate a prioritized checklist of Spanish CWR species, which presently comprises 140 taxa (Rubio Teso *et al*., in prep). Thus in a second approach, the species contained in the above-mentioned genera in the National Inventory of PGRFA were checked, resulting in the identification of 81 common species (column 5).

Data analysis shows that 38% of species of the prioritized CWR checklist are not included in the PGRFA NI. This means that 48 CWR prioritized species are not conserved *ex situ* (Table 2). Similar results have been previously observed in wider studies (Jarvis *et al*., 2008). The collection and *ex situ* conservation of representatives of these species seems like a crucial step, which would be quicker and more feasible than the establishment of *in situ* reserves. Likewise, some additional species belonging to the prioritized genera, but not included in the prioritized checklist of Spanish CWR species, are included in PGRFA *ex situ* collections, particularly the genera *Diplotaxis* DC. with eight and *Vicia* L. with seven species, respectively. These already conserved accessions must be taken into account when the number of prioritized species enlarges with the inclusion of species which presently are considered to be of secondary priority (Maxted *et al*., 2010), since some of these species are included in ongoing CWR global inventories (Vincent *et al*., 2013).

Table 2 Prioritized CWR species not included in the Spanish genebanks

Allium ampeloprasum L.	*Cynara scolymus*L.
Allium commutatum Guss.	*Daucus arcanus* García Martín & Silvestre
Allium melananthum Coincy	*Hordeum zeocriton* L.
Allium palentinum Losa & P. Montserrat	*Lactuca singularis* Wilmott
Allium pruinatum Link ex Spreng.	*Lathyrus bauhini* Genty
Allium pyrenaicum Costa & Vayr.	*Lathyrus cirrhosus* Ser.
Allium rouyi Gaut.	*Lathyrus nudicaulis* (Willk.) Amo
Allium schmitzii Cout.	*Lathyrus pisiformis* L.
Allium sphaerocephalon L.	*Lathyrus pulcher* J. Gay
Allium stearnii Pastor & Valdés	*Lathyrus sativus* L.
Allium subhirsutum L.	*Lathyrus sylvestris* L.
Apium bermejoi L. Llorens	*Lathyrus vivantii* P. Monts
Asparagus albus L.	*Patellifolia patellaris* (Moq.) A. J. Scott, Ford-Lloyd & J.T. Williams
Asparagus aphyllus L.	*Patellifolia procumbens* (C. Sm. ex Hornem.) A. J. Scott, Ford-Lloyd & J. T. Williams
Asparagus arborescens Willd.	*Vicia altissima* Desf.
Asparagus fallax Svent.	*Vicia argentea* Lapeyr.
Asparagus maritimus (L.) Mill.	*Vicia bifoliolata* J. J. Rodr.
Asparagus nesiotes Svent.	*Vicia glauca* C. Presl
Asparagus plocamoides Webb ex Svent.	*Vicia lathyroides* L.
Avena lusitanica (Tab. Morais) R. Baum	*Vicia leucantha* Biv.
Brassica montana Pourr	*Vicia nataliae* U. Reifenberger & Reifenberger
Cichorium spinosum L.	*Vicia pyrenaica* Pourr.
Cynara algarbiensis Coss. ex Mariz	*Vicia sepium* L.
Cynara humilis L.	*Vicia chaetocalyx* Webb & Berthel.

Based on the number of accessions per species, five categories of CWR species were established according to their need of multiplication/regeneration in the Spanish genebanks (Fig. 1). According to this classification the first two levels, which include species with zero or up to five accessions, were considered as a priority for multiplication/regeneration or collection. On the first prioritization level (no accessions), *Allium ampeloprasum* L., *Cynara scolymus* L. and *Lathyrus sativus* L. were found. In the case of the latter species, there are available landraces not considered in this study, since only the wild forms were under study. This is not an exception as other prioritized species also have landraces in the *ex situ* collections consulted (e.g., *Vicia sativa* L., *Apium graveolens* L., *Brassica oleracea* L. and *Pisum sativum* L.).

Vicia pannonica Crantz (Photo: L. De la Rosa)

Nearly half of *ex situ* conserved species are grouped at the prioritization level 2: *Aegilops biuncialis* Vis, *A. geniculata* Roth, *Allium grossii* Font Quer, *A. schoenoprasum* L., *Apium graveolens* L., *Asparagus acutifolius* L., *A. officinalis* L., *A. pastorianus* Webb & Berthel., *A. stipularis* Forssk., *Avena murphyi* Ladiz., *A. prostrata* Ladiz., *Brassica bourgeaui* (Webb ex Christ) Kuntze, *Cicer canariense* A. Santos & G. P. Lewis, *Cynara alba* Boiss. ex DC., *C. cardunculus* L., *C. tournefortii* Boiss. & Reut., *Erucastrum canariense* Webb & Berthel., *Hordeum bulbosum* L., *H. distichon* L., *Lactuca livida* Boiss. & Reut., *L. palmensis* Bolle, *L. perennis* L., *L. saligna* L., *L. serriola* L., *L. virosa* L., *Lathyrus annuus* L., *L. latifolius* L., *L. ochrus* (L.) DC., *L. tuberosus* L., *Lens ervoides* (Brign), *Patellifolia webbiana* (Moq.) A.J. Scott, Ford-Lloyd & J.T. Williams, *Secale montanum* Guss., *Solanum lidii* Sunding, *S. vespertilio* Aiton, *Vicia articulata* Hornem., *V. bithynica* (L.) L., *V. cirrhosa* C. Sm. ex Webb & Berthel., *V. ervilia* (L.) Willd., *V. filicaulis* Webb & Berthel., *V. hybrida* L. and *V. cordata* Hoppe.

Twenty-one species are included at the level of prioritization 3 (6–20 accessions): *Aegilops triuncialis* L., *A. ventricosa* Tausch, *Beta macrocarpa* Guss., *B. vulgaris* subsp *maritima* (L.) Arcang., *Borago officinalis* L., *Brassica balearica* Pers., *B. barrelieri* (L.) Janka, *Capsella bursa-pastoris* (L.) Medik., *Cichorium intybus* L., *Daucus carota* L., *Diplotaxis muralis* (L.) DC., *D. tenuifolia* (L.) DC., *Erucastrum gallicum* (Willd.) O.E. Schulz, *Lathyrus clymenum* L., *L. tingitanus* L., *Pisum sativum* L., *Vicia lutea* L., *V. narbonensis* L., *V. pannonica* Crantz, *V. peregrina* L. and *V. scandens* R. P. Murray.

Lupinus mariae-josephae H. Pascual (Photo: L. De la Rosa)

Species with more than 20 accessions (levels 4 and 5) have a lower risk. However it must be pointed out that a representative sample of the diversity of each species might not be preserved. Therefore the representativeness of the prioritized CWR accessions included in the PGRFA NI should be assessed in future studies. Considering that ecogeographic diversity can be a good proxy of adaptive genetic diversity, the availability of ecogeographic characterization land maps and ecogeographic gap analysis can be a useful alternative to study which species are well sampled, when characterization or evaluation information on the accessions is not available (Parra-Quijano *et al.*, 2008).

"ecogeographic diversity can be a good proxy of adaptive genetic diversity"

In spite of the difficulties associated with the regeneration and multiplication of wild species in a different site than that of provenance, mainly related to the risk of genetic erosion, in some cases their regeneration could be recommended. In this case, the knowledge of the exact site of collection will be very useful. The quality evaluation of the georeferenced passport data of CWR included in the PGRFA NI was conducted following the procedure GEOQUAL described by Parra-Quijano *et al.* (2013). GEOQUAL produced three parameters that measured different aspects of precision and accuracy of the locality description and coordinates from passport data. These three parameters are summarized in the TOTALQUAL100 parameter which offers a global quality value in a 0100 scale. For the complete database of PGRFA NI, the average value of TOTALQUAL100 is 53.23 while the value for the subset of CWR accessions is 45.30. The most limiting quality factor detected by the GEOQUAL method for the CWR accessions was the level of accuracy of the coordinates, many of them obtained up to minutes. The explanation of the lower accuracy of wild species geographic information, especially for the oldest accessions, could be the lack of good georeferencing methods at the time when they were collected, and to the difficulties to improve data later.

In conclusion, although the Spanish PGRFA NI contains a large number of CWR species, the collection has been established taking into account the conservation of biodiversity, but not the presently selected criteria for the prioritization of CWR. This may be the main reason for the existence of vast gaps in the current *ex situ* conservation of these species. In the near future, the regeneration of existing collections, together with collecting missions for less represented CWR conserved *ex situ,* will be prioritized. Although the quality of the georeferencing of the collecting sites described in passport data of CWR included in the Spanish PGRFA NI is higher than that of the complete NI, additional efforts are required to improve their quality so appropriate gap and representativeness analysis can be undertaken.

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