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CURRENT STAGE AND FUTURE PERSPECTIVES OF *EX SITU* PLANT GERMPLASM CONSERVATION IN ROMANIA

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Abstract

Human-induced pressure significantly accelerates the species extinction rate. It is estimated that 27% of European plant species are threatened with extinction. This highlights the urgent need for the conservation of plant genetic resources, which can be achieved through in situ and ex situ methods. Although in situ conservation is preferred, it's not always feasible due to habitat destruction or other environmental or anthropic stresses. Ex situ conservation methods, including germplasm collections in gene banks, are essential for preserving plant genetic diversity. Romania's ex situ conservation efforts are conducted mainly for crop plants and are concentrated in only two gene banks. For wild flora, ex situ conservation is limited to only a few botanical gardens and research institutes. This work aims to assess the current state of ex situ plant conservation in Romania and discusses the opportunities and advantages associated with establishing a National Germplasm Bank for both wild and cultivated species.

Key words*: anthropic pressure, ex situ conservation, gene banks, germplasm collections.*

INTRODUCTION

It is estimated that the current human-induced extinction rate of species is up to 700 times higher than the natural rate (Christenhusz & Govaerts, 2025). Accordingly, recent reports have shown that 19.4% of assessed European species are threatened with extinction, and 27% of European plant species are threatened (Hochkirch et al., 2023).

With the increased risk of species loss, conservation of plant genetic resources becomes a major global challenge. In general, biodiversity loss is minimized by *in situ* and *ex situ* conservation. *In situ* conservation refers to the protection and efficient management of species populations in their natural habitats. Efficient management results in long-term preservation of species' genetic diversity. Under major stress caused by habitat destruction (mainly due to the conversion of natural habitat into farmland), invasive species, pollution, etc., *in situ* conservation, which should be the first choice, is not always possible.

A valuable alternative is the conservation of plant genetic resources outside their natural habitat through *ex situ* conservation. Through *ex situ* conservation, species could be preserved away from the major threats that affect their natural habitats. The techniques and methods of *ex situ* conservation allow species preservation by translocation in botanical gardens or arboreta, or by maintaining them in germplasm collections as seeds and/or living collections (e.g., vitrocollections). A germplasm collection is defined as a collection of genetic material that captures a maximum genetic variability within a species. Usually, a germplasm collection for plant species consists of a collection of seeds, different types of propagules, cells, and tissues. Gene banks store germplasm collections under specific conditions for long-term conservation and sustainable use of genetic resources.

Gene banks were established all over the world, mainly for crop plants and their wild relatives, to maintain the genetic basis needed for breeding. For wild plants, the main purpose of gene bank establishment is to reduce species extinction risk. Until now, more than 354,200 of the world's wild plant species are preserved in gene banks established in botanic gardens (BGCI, 2025).

In Romania, *ex situ* conservation of plant genetic resources is limited to a few botanical gardens, research institutes and only two gene banks. In this context, the aim of the present work was to gather, summarise, and analyse information concerning the current stage of *ex situ*

conservation of plant genetic resources in Romania. Moreover, in light of EU environmental policies, the opportunity of establishing a National Germplasm Bank for both cultivated and wild species is discussed.

MATERIALS AND METHODS

The main research method was to collect and synthesise the available data from publicly available digitised materials, scientific publications, and direct material from the institutions involved in plant conservation. To review the main literature in the field of *ex situ* plant conservation in Romania, systematic research was carried out using the Web of Science and Google Scholar engines. In order to gain updated and reliable data, the main national structures involved in *ex situ* plant conservation efforts were identified from accessible public resources, contacted, and asked for specific information. In addition, a comprehensive screening of available institutional reports, gene bank databases, and *Index Seminum* catalogues was undertaken.

RESULTS AND DISCUSSIONS

Current status of ex situ conservation in Romania

In order to evaluate the *ex situ* conservation status of plant germplasm in Romania, we focused on seed and *in vitro* collections maintained in seed banks, botanical gardens, and research institutes (Tables 1 and 2):

- **Gene banks** - according to publicly available data, there are only two in Romania:

1. *Vegetal Genetic Resources Bank "Mihai Cristea" Suceava* holds an important collection of spontaneous flora and wild relatives of cultivated plants in Romania, preserved as seeds or propagules under medium (+4°C) or long-term (-20°C) storage conditions, and *in vitro* collections, totaling 428 species. The medium-term collection includes 844 samples of 186 species from 131 countries, while the long-term collection is smaller, including selected genotypes totaling 36 samples representing 14 species from four countries. Specifically, for Romanian spontaneous flora, there are 627 samples belonging to 141 species maintained mainly in medium-term storage, and only 28 samples from 11 species are preserved in long-term storage. Wild relatives of cultivated plants (CWR) are also conserved, totaling 295 samples of 45 species stored medium-term, and only 36 samples from 14 species are stored long-term. Notable genera include *Amaranthus*, *Dactylis*, *Avena*, and *Aegilops*. An extensive study on CWR was conducted in 2021 by Șandru, presenting a checklist of 525 wild plant species native to Romania, from which a National Priority List of 275 species was compiled, with ca. 10% preserved in the Suceava Gene Bank. These collections are vital for conservation and research purposes, ensuring the preservation of plant biodiversity from Romania and beyond.

In conclusion, from a total of 18,883 accessions, only 3.32% are wild species and 1.56% are CWR, the main collection representing crops (95.12%).

2. *The Plant Genetic Resources Bank for Vegetable, Floriculture, Aromatic and Medicinal Plants Buzău* has 296 registrations in its collections, mostly of crops.

- **Botanical Gardens**:

1. *"Dimitrie Brandza" Botanical Garden, Bucharest,* maintains a seed collection (890 taxa; *Delectus seminum*, 2025) of spontaneous and cultivated species in the botanical garden or collected from other areas of the country, at room temperature, for short-term storage of about 2-3 years.
2. *"A. Borza" Botanical Garden, Babeș-Bolyai University, Cluj-Napoca,* holds seeds from 879 taxa collected from plants cultivated in the botanical garden and from 53 taxa collected from the spontaneous flora (*Delectus Seminum*, 2019).
3. *The Botanical Garden of the University of Agricultural Sciences and Veterinary Medicine (USAMV), Cluj-Napoca,* has a seed collection for annual exchanges with other botanical gardens. For 2025, there are 879 accessions, all with international IPEN codes and all registered in Botanic Gardens Conservation International (BGCI)'s Plant

Search database. Some samples originate from plants collected from their natural habitats.

4. *"Alexandru Buia" Botanical Garden, Craiova,* maintains in its collections spores and seeds from 497 taxa of cultivated plants in the botanical garden and seeds from 45 taxa collected from various Romanian regions, totaling 542 taxa, including species, subspecies, and varieties (*Index Seminum*, 2023).
5. *"Anastasie Fătu" Botanical Garden, Iaşi (BGI),* is a member of the Association of Botanical Gardens of Romania (AGBR). The collection comprises seeds from 1281 taxa of cultivated plants in the Botanical Garden, 91 taxa from spontaneous plants within the garden, 771 taxa from various Romanian regions, and 18 taxa from global locations – all collected in 2025 – totaling 2,161 taxa (*Index Seminum* of the "Anastasie Fătu" Botanical Garden, Iaşi, 2025). The collection is maintained short-term and is intended for exchange and research. Within the international seed exchange, BGI sends ca. 3,500 seed samples yearly to more than 80 countries.
6. *Botanical Garden* "*Vasile Fati", Jibou, (Sălaj),* is a member of BGCI and the AGBR. The seed collections are kept for at most four years, which is the good viability period for most seeds, but updated and replaced each year for the international seed exchange with other botanical gardens. The seed catalogue for the year 2025 (No. 51) contains 1,646 taxa. The "cultivated spontaneous plants" in the botanical garden represent 881 species and are part of the spontaneous flora of Romania. The "species from the spontaneous flora of the garden" number 718 species and are also considered part of the garden's collections, but they reproduce on their own, and most are remnants of the indigenous flora of the land where the botanical garden is currently located (forest flora, meadows, and valleys near watercourses). The *in vitro* collections currently held include the species *Stevia rebaudiana, Pinguicula gigantea, Vanilla planifolia,* and *Cymbidium* sp. A detailed analysis of the species from this botanical garden was conducted by Szatmari & Căprar (2015).
7. *Botanical Garden, Galaţi,* maintains in its collection the seeds harvested from cultivated plants in the botanical garden and from those growing spontaneously in the garden area, as well as from spontaneous species in various counties of Romania (Galați, Tulcea, and Constanța), totaling 819 taxa (*Index Seminum* of the Botanical Garden, Galaţi, 2025).
8. *Macea Botanical Garden* is affiliated with "Vasile Goldiş" University, Arad, a member of AGBR, and cultivates over 2,000 tree and shrub species and ca. 500 herbaceous species.

In addition, botanical gardens make a significant contribution to *ex situ* wild plant conservation through the establishment of outdoor collections (living collections) of endangered plant species. Recent estimates showed that a number of 524 native endangered taxa are grown in botanical gardens across Romania, but the total number of threatened and (sub)endemic taxa from the Romanian flora held by botanical gardens nationwide is significantly higher, totaling 925 taxa (Hurdu et al., 2022). Thus, to date, botanical gardens are the most important structures that contribute to ex situ conservation of wild Romanian flora.

- **Research Institutes**:

1. *Institute of Biology Bucharest of the Romanian Academy* (IBB) advanced *in vitro* plant conservation and biotechnology research through four stages between 1975 and 2005, evolving from fundamental studies on cytodifferentiation, protoplasts, and genetic transfer to applications in clonal propagation, stress tolerance, and secondary metabolite production (Brezeanu & Cogălniceanu, 2016). Currently, IBB focuses on *ex situ* conservation of endangered, medicinal, or economically important phytotaxons.

Through the PeatRO Projects (PeatRO2, PeatRO3, and PeatRO4), IBB took its first steps toward establishing a National Germplasm Bank by including 29 peatlands' plant species in seed collections (Figure 1) and 14 species in *vitro* collections (Figure 2) – a total of 32 different species conserved *via* both techniques.

Currently, IBB maintains *in vitro* collections of 21 vascular plant species from Romania's spontaneous flora, 1 bryophyte species (25

species were maintained for varying periods between 2005 and 2010, but only six remained by 2013; Cogălniceanu, 2014), and 5 pteridophyte species, totaling 27 plant species. Over time, regeneration and maintenance protocols have been developed for many additional species, comprising a valuable knowledge database for future conservation efforts.

2. *Institute of Biological Research Cluj-Napoca* developed *in vitro* protocols for both wild and cultivated species, totaling ca. 24 species. Seed collection was established as a common effort with the "*Alexandru Borza" Botanic Garden* (Cluj-Napoca) and is focused on the wild, threatened and (sub)endemic flora of Romania, totaling 321 samples from 285 taxa (Hurdu et al., 2022).
3. *National Research and Development Institute* (NARDI) *Fundulea,* currently maintains in the active collection 17 wild species of the genus *Helianthus*.
4. *Vegetable Research and Development Station Buzău* (SCDL Buzău) holds a germplasm collection with ca. 103 species and 2,641 accessions - crops and wild relatives of crops (CWR).
5. *The State Institute for Testing and Registration of Varieties* (ISTIS) holds seeds for 11,717 varieties from 134 species - only from crop plants.
6. *National Institute of Research and Development for Potato and Sugar Beet Braşov* (NIRDPSB) conserves, within the Laboratory for Plant Tissue Culture Research, an *in vitro* germplasm collection that includes both Romanian (32) and foreign potato varieties (25), as well as wild species (2). Additionally, alongside potatoes, there are five sweet potato genotypes.

- **Associations**:

1. *EcoRuralis* - the database initiated in 2014, with entries made until March 2023, has a total of 841 entries, from ca. 100 species - crops and crop wild relatives (CWR). Currently, the seeds are stored in "seed houses" from 14 counties, dedicated more to a seed system that encourages seed circulation and production.
2. *The Community Seed Bank "Seed House"* - developed with mentoring and support from the International Association of Seed Savers (Austria) - is dedicated to saving, preserving, and multiplying the old, traditional, and rare Romanian seeds. Currently holds in its collection ca. 500 samples from over 250 varieties of legumes, ornamental, and medicinal plants.

Another valuable means of *ex situ* conservation is the establishment of *in vitro* collections. It was estimated that a total number of 64 native, endangered species are maintained in *in vitro* collections of the Institute of Biology Bucharest, Alexandru Borza Botanic Garden, and Institute of Biological Research Cluj-Napoca (Hurdu et al., 2022).



Figure 1. Seed collections of wild flora maintained at the Institute of Biology Bucharest of the Romanian Academy (Photo by Anca Manole)



Figure 2. *In vitro* collections of wild flora maintained at the Institute of Biology Bucharest of the Romanian Academy (Photo by Anca Manole)

Table 1*. Relevant national institutions housing seed collections

No.	Institution name	Number of accessions / species / taxa	Wild species	Crops	Crop wild relatives (CWR)	Link
Gene Banks						
1.	*Vegetal Genetic Resources Bank "Mihai Cristea" Suceava – BRGVSV*	18,883 accessions 428 species	627 accessions 141 species from Romania	x	295 accessions 45 species 21 countries	https://svgenebank.ro/
2.	*The Plant Genetic Resources Bank for Vegetable, Floriculture, Aromatic and Medicinal Plants [BRGV] Buzău*	296 species	-	x	x	https://brgv.ro/
Botanical Gardens						
1.	*"Dimitrie Brandza" Botanical Garden, Bucharest*	890 species	92 species collected from wild flora	-	x	https://gradina-botanica.unibuc.ro/
2.	*"A. Borza" Botanical Garden, Babeş-Bolyai University, Cluj*	879 species (2019)	53 species collected from wild flora	x	x	https://gradinabotanica.ubbcluj.ro/
3.	*The Agro-Botanical Garden of the University of Agricultural Sciences and Veterinary Medicine (USAMV) Cluj-Napoca*	879 accessions	X	x	x	https://www.usamvcluj.ro/universitatea/gradina-botanica/
4.	*"Alexandru Buia" Botanical Garden, University of Craiova*	542 species (2023)	ca. 45 species collected from wild flora	x	x	https://www.ucv.ro/campus/puncte_de_atractie/gradina_botanica/prezentare.php
5.	*"Anastasie Fătu" Botanical Garden, Iaşi*	2,161 species	ca. 900 species originate from wild flora	-	x	https://www.botanica.uaic.ro/home.html
6.	*"Vasile Fati" Botanical Garden, Jibou*	1,646 species		-	-	https://ccbjb.ro/
7.	*Botanical Garden, Galaţi*	819 species	ca. 120 species collected from wild flora	-	x	https://cmsngl.ro/
Other Institutions						
Research Institutes						
1.	*Institute of Biology Bucharest of the Romanian Academy*	27 species	x	x	-	https://ibiol.ro/
2.	*National Agricultural Research and Development Institute (NARDI) Fundulea*	17 wild species of the genus *Helianthus*	-	x	x	https://incda-fundulea.ro/index_en.html
3.	*Vegetable Research and Development Station Buzău SCDL*	ca. 103 species 2,641 accessions	-	x	x	https://scdlbuzau.ro/en/home
4.	*The State Institute for Testing and Registration of Varieties (I.S.T.I.S.)*	11,717 varieties from 134 species	-	x	-	https://istis.ro/
5.	*National Institute of Research and Development for Potato and Sugar Beet Braşov (NIRDPSB)*	ca. 59 accessions	x	-	x	https://potato.ro/en/
Universities						
1.	*University of Life Sciences "King Mihai I" from Timisoara*	166 species (Crop production)	-	x	x	https://www.usab-tm.ro/en
Associations						
1.	*"Eco Ruralis" Association*	841 accessions from ca. 100 species	-	x	x	https://www.ecoruralis.ro/despre-noi/asociatia/
2.	*The Community Seed Bank "Seed House"*	over 500 accessions from 250 varieties	-	x	-	https://www.casa-semintelor.ro/en/

Table 2*. Summary table of national institutions housing seed collections

Institution	Accessions / species (approximately)	~% wild species	Main focus
Gene banks	19,179	<5%	Crops + CWR
Botanical Gardens	7,816	<20%	Ornamental species
Other institutions	15,941	<5%	Crops

**Data limitations*: *Data relies on accessible public sources - institutional reports, gene bank databases, Index Seminum catalogues and data provided by collection holders; unreported holdings may exist.*

Grounds for Romanian Flora Conservation

Romania is noted for its rich biodiversity, particularly in the Carpathian Mountains and the Danube Delta. For example, the Carpathians are considered the northernmost diversity hotspot in temperate Europe, featuring rich biodiversity and a significant percentage of endemic phytotaxa (Figure 3) (Breman et al., 2020). Unfortunately, biodiversity hotspots correlate with high extinction rates (Le Roux et al., 2019).



Figure 3. *Dianthus callizonus* Schott & Kotschy, an emblematic endemic species for Romanian Flora (Photo by Anca Manole)

This is documented by the available national red lists of wild plant species, which include more than one-third of Romanian vascular plants. For example, in the most cited national red list of vascular plants, published more than 30 years ago (Oltean et al., 1994), 1,235 species out of a total of 3,795 of Romanian flora were included in different endangered categories (Dihoru & Negrean, 2009). The current number of plant species included in national Red Lists is significantly higher, being estimated at 1,453 threatened and (sub)endemic plant taxa, representing almost 38% of the total native vascular flora of Romania (Hurdu et al., 2022).

Future perspectives to strengthen and integrate national ex situ conservation actions

While Romanian gene banks preserve germplasm under medium (+4°C) and long-term (-20°C) storage conditions, most botanical gardens store short-term collections, underscoring the need for a centralised conservation unit and facilities for long-term seed storage. Moreover, the main institutions involved in *ex situ* plant conservation, with the exception of botanical gardens and a few research institutes, prioritise crops, leaving Romania's rich wild flora under-preserved.

Taking into account the current stage of plant conservation in Romania, a necessary requirement to integrate and strengthen the national efforts for *ex situ* conservation of plant genetic resources is to establish a National Germplasm Bank. The advantages of establishing a National Germplasm Bank include:

- filling the gap of wild flora conservation by establishing a comprehensive *ex situ* collection of spontaneous species;
- facilitate the implementation of national and international environmental policies (e.g., the EU's Biodiversity Strategy for 2030, a key component of the EU Green Deal);
- provide a unitary framework for *ex situ* plant conservation;
- ease the integration in international conservation programs and networks;
- ensure a national reserve of plant genetic resources as a quadrant for sustainable development.

CONCLUSIONS

Ex situ plant germplasm conservation in Romania is predominantly crop-orientated, totalling 42,936 accessions. From these, approximately half is concentrated in the *Vegetal Genetic Resources Bank "Mihai Cristea" Suceava. Ex situ* conservation of wild flora germplasm in Romania is scarce and represents less than 10% of the total number of preserved species and less than 15% of the native wild species. Moreover, the existing *ex*

situ seed collections, with very few exceptions, are for short-term storage and are established mainly for seed exchange (botanical gardens) or improvement (National Institutes). Establishment of the National Germplasm Bank is a reliable means to integrate and centralize conservation efforts to preserve plant diversity from Romania and will ensure long-term preservation and sustainable use of native plant germplasm.

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