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History and current status of plant genetic resources conserved and maintained by the Hungarian central genebank

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Abstract: The predecessor of the National Centre for Biodiversity and Gene Conservation (NBGK) was established in Hungary in 1959. The 1950s were hectic times for Hungarian plant breeders, and many new genetic materials were registered in the National List of Varieties. In order to save obsolete genetic resources, in 1959 the government founded the Agrobotanical Institute at Tápiószele to prevent plant genetic erosion in the Pannonian region. The centre started its operation with 16,596 accessions. Their quantity continuously increased thanks to collecting missions and international connections. The NBGK collection is composed of cereals (37.3%), vegetables (18.7%), legumes (17.4%), industrial crops (5.29%), fruits and grapes (3.85%) and others. NBGK has operated under its current name since 2019 with the same mission as when it was first established. Today, it is the seventh largest genebank in Europe with 57,381 accessions of 1,745 plant species across 605 genera. Almost 95% of samples are maintained in the form of seeds in 15 cooled storage rooms (at temperatures of 5–8°C or -18°C), while the others are conserved *in vitro*, in the form of tubers or field collections. Sharing genetic materials has been a crucial part of the institute's activities since the beginning. Between 2019 and 2023, a total of 92,100 samples were distributed to a variety of partners, mainly gardeners and farmers (83.85%) and NGOs (14.63%). Researchers, breeders and universities account for only 1.52% of seed requests, which is the opposite of what is observed in other genebanks.

Keywords: plant genetic resources, gene conservation, *ex situ*, seed bank, Pannonian region

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Foundation of the Hungarian genebank

The history of the National Centre for Biodiversity and Gene Conservation (Hungarian abbreviation NBGK) and its legal predecessor institutes started in the 1880s. Dr Lajos Szelényi, a Hungarian doctor born in Kismarton (today Eisenstadt, Austria), moved to Budapest after finishing his university studies in Vienna. Besides his healing activities, he was famous for his charity work. He donated large sums of money to Austrian and Hungarian medical and agricultural science. Dr Szelényi purchased 400 acres of land in Tápiószele, in the Central Hungarian Region, which he donated to the National Hungarian Economic Association in his 1885 will, specifying that the land was to be used by future generations for agricultural experiments and vocational education in agriculture. The work of the first few decades was destroyed several times by the World Wars, revolutions and political transformations. The 1950s were hectic times for Hungarian plant breeders, and many new genetic materials were registered in the National List of Varieties. In order to save the old and obsolete varieties, collection departments were established at the breeding institutions. The Agrobotanical Institute was established on the land in Tápiószele left by Dr Szelényi under the leadership of Dr Andor Jánossy (1908–1975) based on a government initiative in 1959, with the aim of integrating the genetic resource collections of the country and preventing genetic erosion (Jánossy,

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1971). Despite several institutional reorganizations and changes of responsible organizations, the Hungarian genebank operated under its current name and form since 2019, and its function and scope of duties have changed little over the last 65 years. Currently, the NBGK operates as a central budgetary institution fulfilling public functions. It is maintained by the Hungarian Ministry of Agriculture, with 50% of its annual budget financed by the government and the other 50% covered through grants. The majority of these grants come from national sources, but some are financed by the European Union.

Composition and expansion of the collection

The institute started its operation with 16,596 accessions of 871 plant species. According to our database, the starting number of accessions included both Hungarian and foreign materials. The number of accessions has continuously increased thanks to wide international scientific connections and collecting expeditions in Hungary and across the Carpathian Basin. Since its establishment, the institute has exchanged genetic materials with around 400 other institutes, but development through collecting missions also has a long tradition in the genebank (Guerrant *et al*, 2014). Our founder and first director, Dr Andor Jánossy, recognized already at the beginning of the 1950s that landraces were going to disappear from public production due to the spread of large-scale industrialized agriculture. He was one of the first in the world to collect cereals, fodder crops, maize and vegetable landraces and local varieties in cooperation with his colleagues before they became lost from production, replaced by high-yielding, intensively farmed improved varieties. This activity has always been regarded as an important duty of the institute, and it is still carried out today, for example in the case of fig genotypes. In 2023, we collected 22 fig (*Ficus carica* L.) genotypes from the northern shore of Lake Balaton, one from Budapest and another one from West Hungary. During the collecting trips, we measured and characterized fruits, leaves and branches. The collected twigs are propagated in our nursery. As part of the Pannon Seed Bank Project (a LIFE+ programme, LIFE08 NAT/H/000288), 2,064 accessions were collected between 2010 and 2014. These are vascular wild plants of the Pannonian biogeographical region and wild relatives of cultivated plant species (Hay and Probert, 2013; Walters *et al*, 2018). In the last 70 years, plant genetic resources have been collected from a total of 1,504 locations (Figure 1), adding 13,785 accessions of Hungarian origin to the collection of NBGK (Table 1). Today, collection work is also carried out abroad, thanks to collecting trips jointly organized with the genebanks of neighbouring countries (Slovakia and Romania). This has resulted in 2,477 landraces, local varieties, populations and ecotypes being collected from 340 locations. In addition, a further 237 accessions collected by foreign genebanks have been shipped to our institute through seed exchange.

With regard to the amount of conserved genetic material, NBGK is the seventh largest genebank in Europe today, preserving 57,381 accessions of 1,745 species from 605 genera. Our oldest accessions date back to the early 1950s. Both the number of accessions and taxa was continuously increased until the 2010s, with a levelling off in the 2020s (Figure 2).

Regarding the composition of the different plant groups (Table 2), our collection is dominated by cereals with 21,376 accessions, making up 37.3% of the collection. Besides the major spiked cereals like wheat (*Triticum* spp.) and barley (*Hordeum* spp.), maize (*Zea* spp.) and sorghum (*Sorghum* spp.), pseudocereals like amaranths (*Amaranthus* spp.), certain buckwheat species (*Fagopyrum* spp.), finger milet (*Eleusine coracana* (L.) Gaertn.) and teff (*Eragrostis tef* (Zucc.) Trotter) also belong to this group. Vegetables and grain legumes constitute 18.7% and 17.4% of the collection, respectively. The former group consists of the collections of tomato (*Lycopersicon* spp.), paprika (*Capsicum* spp.), Cucurbitaceae, onions (*Allium* spp.), root and leafy vegetables and other vegetables (e.g. *Physalis* spp.). Almost half of the grain legumes collection (4,322) is composed of *Phaseolus* species accessions originating from the American centre of origin and diversity, but pea (*Pisum* spp.), chickpea (*Cicer* spp.), lentil (*Lens* spp.) and soybean (*Glycine* spp.) accessions are also present. The three above-mentioned groups constitute 73.4% of the whole collection. The group of industrial crops containing 3,040 accessions includes genera such as sunflower (*Helianthus* spp.), flax (*Linum* spp.), poppy (*Papaver* spp.) and the neglected camelina (*Camelina* spp.) used for oil production. The group of forage legumes includes the accessions of 113 species from 20 genera, the most important of which are clovers (*Trifolium* spp.), alfalfas (*Medicago* spp.) and vetches (*Vicia* spp.) constituting 80.7% of this group. In terms of the number of taxa, Poaceae species are the second most diverse group (the first being herbs like medical plants from Lamiaceae and Asteraceae families) including 171 species of 51 genera. Almost half of the 2,298 accessions of grasses have been collected. Accessions of the Pannon Seed Bank are listed as a separate group.

The accessions of the above-mentioned utilization groups are stored generatively as seeds in the genebank, equating to 94.44% of the collection. Besides this method, the institute has other ways of preserving plant genetic resources. Although such samples are only a small part of the collection, they are very valuable. In recent years, the ratio of collections preserved in the form of field collections has increased. Woody fruit crops, grapes and ornamentals are in this group, composing 3.85% of the collection. The collection of potato (*Solanum tuberosum* L.) and its wild relatives are preserved *in vitro* (Engelmann, 2011), constituting 1.24% of the genebank collections. From the group of tuber crops, Jerusalem artichoke (*Helianthus tuberosus* L.), sweet potato (*Ipomoea batatas* L.) and onions

(*Allium* spp.) are preserved vegetatively, making up 0.47% of the collections.

Multiplication and maintenance of genebank accessions

Genotypes stored in the form of seeds, tubers, bulbs or *in vitro* are reproduced in the field if the minimal number of seeds required for genebank storage has to be reached, viability has declined, taxonomic analyses are necessary, the accession needs to be multiplied for distribution purposes, or experiments are required to be performed. Accessions conserved in the form of field collection are kept always outside in the fields. Three professional teams carry out the work related to such duties: the Department of Arable Crops, the Department of Horticultural Crops and the Department of Fruit Crops. The annual sowing plan is defined by the number of accessions requiring regeneration for the above-mentioned reasons and the number of spatially isolated field plots available for sowing. The number of accessions regenerated by growing new individuals in the field in the last 10 years is shown in Table 3.

The number of accessions sown from the different plant groups fluctuates yearly. This is not only because the different collections contain a different number of accessions, but also due to the diversity of factors that need to be considered during multiplication. Between 2014 and 2023 plant groups with large collections – such as grain legumes, cereals, herbs and onions – dominated the multiplication process every year. Consequently, members of the *Phaseolus*, *Triticum*, *Allium*, *Lycopersicon*, *Origanum* and *Capsicum* genera reached the highest levels of multiplication in the last ten years. In this period, common bean (*Phaseolus vulgaris* L.) and winter wheat (*Triticum aestivum* L.) were the most frequently multiplied species. The genebank established its fruit crop collection in 2013. Due to its continuous expansion, today it contains 1,212 accessions. Besides the members of the Maloideae subfamily (apple (*Malus domestica* Borkh.), pear (*Pyrus communis* L.), medlar (*Mespilus germanica* J.B. Phipps), quince (*Cydonia oblonga* Mill.)), stone fruits (plum (*Prunus domestica* L.), sour cherry (*Prunus cerasus* L.), cherry (*Prunus avium* L.), peach (*Prunus persica* L.), apricot (*Prunus armeniaca* L.)) and other fruit species – such as Cornelian cherry (*Cornus mas* L.) and service tree (*Sorbus* spp.) – are also found in the almost 9ha plantation. Furthermore, the collection is complemented by a 1ha walnut (*Juglans regia* L.) plantation and a 0.3ha grape (*Vitis vinifera* L.) plantation. Usually, three individual plants are conserved for each genotype. The first plants started to produce fruit in 2020. Our institute has conserved a vegetative collection of ornamental plant varieties (*Iris, Hemerocallis, Hibiscus, Hosta* spp.) of 976 accessions in the nurseries of the genebank since 2017. There is also a rare and old woody plant stand in the central site of the genebank, which functions as a locally protected arboretum. Some of the oak trees of the garden have been planted around the mansion (currently the main building) already in the time of Dr Lajos Szelényi. Unfortunately, the majority of the original English park died. The current garden was planted by the employees of the institute in the 1960s and 1970s. About 350 tree and bush species live here, including several rare ones like the Californian white oak (*Quercus lobata* Née), the Oregon cypress (*Hesperocyparis bakeri* Bartel), the Algerian fir (*Abies numidica* de Lannoy), the Trojan fir (*Abies nordmanniana* subsp. *equi-trojani* Spach), the Cilician fir (*Abies cilicica* Carrière), the Spanish fir (*Abies pinsapo* Boiss.), the Turkish fir (*Abies bornmuelleriana* Coode & Cullen), the Lebanon cedar (*Cedrus libani* subsp. *libani* A. Rich.) and the mountain pine (*Pinus uncinata* Turra).

The agrobotanical analysis and the assessment of the morphological biodiversity of plants sown in the fields are carried out by taxonomists according to Hungarian and international guidelines (Table 4). The descriptors used for characterization are based on the descriptors lists of the International Union for the Protection of New Varieties of Plants (UPOV, 2005), the International Board of Plant Genetic Resources (IBPGR) (Thormann *et al*, 2018), the European Cooperative Programme for Plant Genetic Resources (ECPGR) and in the case of grapes the International Organisation of Vine and Wine (OIV) (Hannin *et al*, 2006). For some plant species, we have refined or complemented the criteria system for agrobotanical analysis. For example, in the case of carrot, the UPOV guidelines have been integrated with the IBPGR descriptors and as a result, the following features are also recorded: colour of core, colour of cortex, root diameter of core relative to total diameter, and homogeneity of flesh colouring throughout root length. Today these characterization data are almost always confirmed by photos as well. Data are documented electronically and then assessed and stored in the database of the institute. The digitalization of the former paper-based agrobotanical analyses is a great challenge for us.

Human resources, infrastructural developments

The Hungarian genebank started its operation with 81 permanent workers in 1959. The number of employees exceeded 200 within ten years. Our first director, Dr Andor Jánossy, put great emphasis on scientific research, so he hired many researchers. Being a member of the genebank's staff was prestigious in the 1970s. Political transformations that occurred in Hungary in 1990 led to the decline of the institute. Due to financial reasons, the number of employees was reduced to only 40 people within a few years, and the survival of the institute was at risk. Fortunately, since 2010 the Hungarian government has considered conservation of plant genetic diversity as an important issue once again, with a public function of strategic importance. Today the institute has 130 employees (Figure 3), six of which are scientists (dealing with research and development). More than 35% of workers have a university degree.

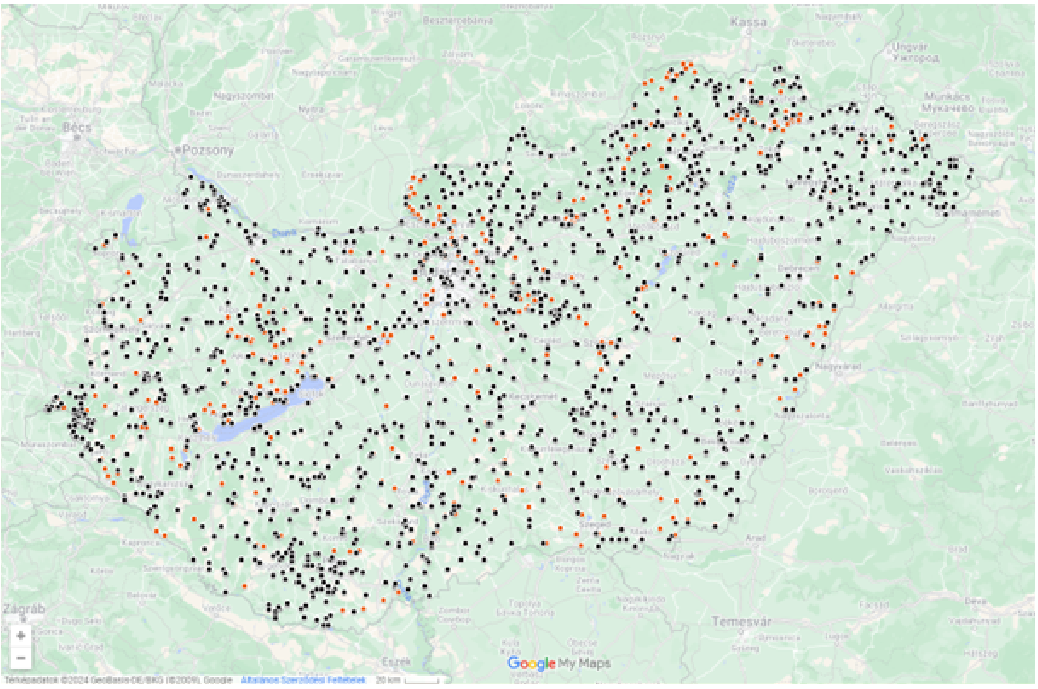

Figure 1. Collection activity of the National Centre for Biodiversity and Gene Conservation (NBGK) in Hungary (1950–2023). Black, cultivated plants; red, wild plants (Pannon Seed Bank). End of data collection: 31 December 2023 (Google Maps).

Table 1. Division of collected accessions by place of origin

Places of collection	NBGK		Pannon Seed Bank		Total	
	Accessions	Locations	Accessions	Locations	Accessions	Locations
Hungary	11,802	1,322	1,983	416	13,785	1,504
Neighbouring country	2,396	319	81	21	2,477	340
Other country	237	166	0	0	237	166
Total	**14,435**	**1,807**	**2,064**	**437**	**16,499**	**2,010**

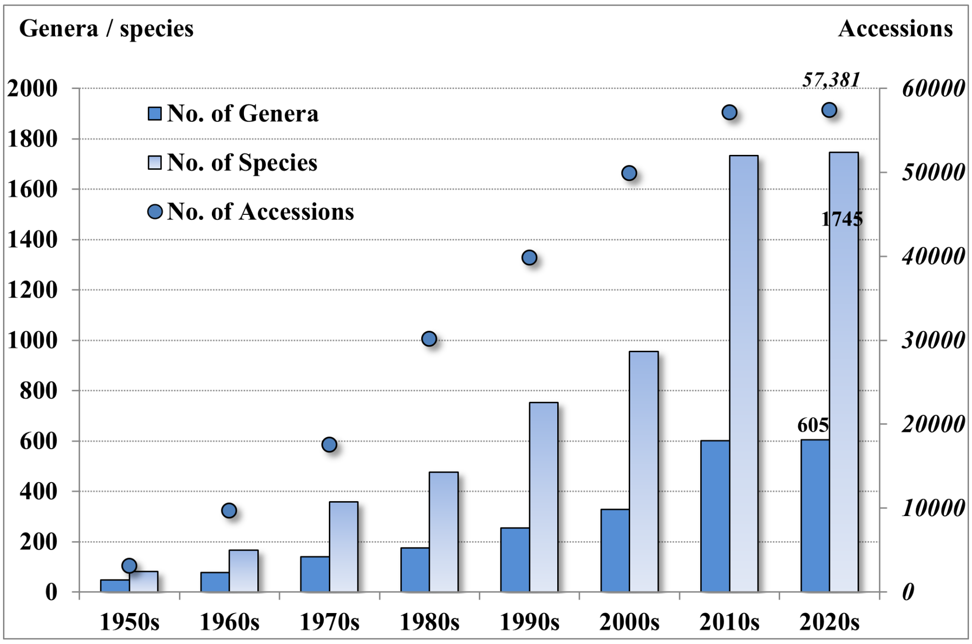

Figure 2. The increasing number of genera, species and accessions maintained by the National Centre for Biodiversity and Gene Conservation (NBGK) from the date of its founding until now. End of data collection: 31 December 2023.

Table 2. Division of the National Centre for Biodiversity and Gene Conservation (NBGK) collection by utilization groups. *, roots and tubers, ornamentals and fruit crops.

Method of conservation	Plant utilization group	Accessions	Ratio of the whole collection (%)
Generative (94.44%)	Cereals	21,376	37.3%
	Vegetables	10,739	18.7%
	Grain legumes	10,002	17.4%
	Industrial crops	3,040	5.3%
	Fodder legumes	2,823	4.9%
	Grasses	2,298	4.0%
	Herbs	1,163	2.0%
	Others *	687	1.2%
	Wild species (Pannon Seed Bank)	2,064	3.6%
Vegetative (0.47%)	Tuber crops	63	0.1%
	Onions	209	0.4%
In vitro (1.24%)	Potato and its wild relatives	709	1.2%
Plantation (3.85%)	Woody fruit crops	1,051	1.8%
	Ornamentals	996	1.7%
	Grapes	161	0.3%
Total		**57,381**	**100,0%**

Table 3. Yearly number of accessions regenerated in the field between 2014 and 2023 divided by plant groups. DAC, Department of Arable Crops; DHC, Department of Horticultural Crops.

	Plant group	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
DAC	Grain legumes	2,984	2,286	2,647	2,166	1,717	1,952	2,040	2,550	2,320	1,879
	Cereals	1,657	1,071	1,712	1,445	2,542	2,163	2,049	2,089	2,725	2,582
	Fodder legumes	720	566	484	382	646	583	491	360	367	330
	Grasses	395	364	367	478	827	621	499	239	235	296
	Industrial crops	296	207	214	231	314	384	418	274	229	289
	Cucurbitaceae	370	155	218	126	120	261	238	140	98	130
	Root and tuber crops	96	98	110	128	158	120	102	79	98	100
	Pseudocereals	34	69	78	51	16	18	52	27	20	48
	Total	**6,552**	**4,816**	**5,830**	**5,007**	**6,340**	**6,102**	**5,889**	**5,758**	**6,092**	**5,654**
DHC	Onions	235	294	286	321	288	441	403	346	327	345
	Tomato	67	56	82	51	49	102	138	70	50	71
	Paprika	84	54	53	47	44	80	112	53	26	53
	Other Solanaceae	66	26	56	7	11	17	30	4	8	6
	Root vegetables	123	81	85	99	90	181	184	132	114	128
	Leafy vegetables	161	100	51	60	61	160	160	98	87	124
	Brassicaceae	50	27	56	45	29	52	67	30	41	30
	Cucurbitaceae	149	42	19	5	14	51	47	72	39	39
	Herbs	53	69	234	221	207	270	708	561	602	467
	Ornamentals	33	12	23	25	43	65	52	192	140	151
	Other vegetables	9	3	0	0	0	0	8	0	0	0
	Total	**1,030**	**764**	**945**	**881**	**836**	**1,419**	**1,909**	**1,558**	**1,434**	**1,414**

Table 4. Descriptors for morphological diversity – an example using the agrobotanical description of a pear landrace according to the UPOV guidelines (2023).

Name of variety	'Hidegkúti nyári' summer pear
Shoot shape	Straight, the internodes are long
Shoot colour	Brown-red on the sunny side with few lenticels
Vegetative bud	Rounded, markedly held out from shoot
Bud support size	Medium
Average shoot length	62cm
Average internode length/thickness	27.4mm/4.24mm
Average leaf length/width	61.2mm/32.9mm
Average petiole length/thickness	36mm/0.56mm
Flower bud	Short, mainly on spurs
Petals	Long, overlap, small in size, ovate in shape
Position of stigma	Mostly above the level of the anthers
Time of maturity	End of July – beginning of August
Fruit size	Short in height, small in diameter, the height-to-diameter ratio is approximately 1:1
Average fruit height/diameter	51.9mm/55mm
Average fruit weight	68.1g
Fruit shape	The maximum diameter is in the centre of the fruit, the fruit is longitudinally symmetrical and the lateral shape is convex
Fruit ground colour	Yellow
Fruit cover colour	Absent
Area of russet	Small around the eye basin, none on the cheeks and around the stalk attachment
Stalk shape	Moderately long and thick, slightly curved, straight in relation to the axis of the fruit
Average stalk length/thickness	28.5mm/9.5mm
Average stalk cavity depth/width	1.1mm/12.8mm
Average eye basin dept /width	3.2mm/16.4mm
Flesh	Soft, medium juicy, fine structure
Sugar content	17.4Bx°
Seed	Elliptic

Figure 3. Staff of the National Centre for Biodiversity and Gene Conservation (NBGK) in summer 2022. Photo by Gergely Gócsa, w ww.gocsafoto.hu

The infrastructure of the genebank – including the buildings and equipment – has continuously developed over time. During the first decade, seed conservation was carried out by storing the seeds in paper bags at room temperature. The first cold storage room – operating at 4°C – was built in 1971. At the time, this was one of the first seed storage rooms of its kind in Europe. In order to make seed storage more effective, paper bags were replaced by aluminium bags and glass jars. As a result of large investment in recent years, one of our old buildings has been completely renovated (Figure 4). From 2024, all the cold storage rooms, seed drying rooms, and germination testing laboratory are located in the same place. Currently, 15 cold storage rooms are operating for direct seed conservation purposes. There are nine active storage rooms running at a temperature of 5–8°C ensuring medium-term conservation, and we have six base storage rooms cooling seeds to -18°C for long-term storage of genebank accessions of orthodox species (Dickie *et al*, 1990; Nagel and Börner, 2010). From the latter base storage rooms, three rooms have a special status: the National Base Storage Room, the Pannon Seed Bank and the Safety Duplicate Storage Room.

The National Base Storage Room has been used since 1996, with the aim of maintaining safety duplicates from the collections of the other Hungarian gene conservation institutes at no cost. So far, 26 Hungarian gene conservation institutes have sent genetic materials totalling 16,966 accessions of 219 plant species from 124 genera. The Pannon Seed Bank project was a LIFE+ programme running between 2011 and 2015, aiming at the long-term conservation of native plant species of the Pannonian Biogeographical Region whose seeds can be stored with this technology. After a transition period, we rethought the project, and continued the monitoring and collection of wild plant species from the region in 2017. This cold storage room contains 2,064 accessions of 921 species from 430 genera today. In 2014 our genebank built the Safety Duplicate Storage Room with the support of the Hungarian Ministry of Agriculture and the Aggtelek National Park in the strictly guarded passage of a dripstone cave. The role of this storage room is to duplicate the seeds of the most important plant genetic resources for food and agriculture (25% of the whole collection), including landraces, local populations and ecotypes collected from the Carpathian Basin and also old varieties that have disappeared from public production. So far, 6,733 accessions of 289 species from 159 genera have been put in the Safety Duplicate Storage Room.

Our equipment has been continuously modernized over the last 10 years, with the decreasing availability of physical labour force, driving us to purchase modern machines. Our former plot seeder and harvester have been replaced by new machinery in the last 1–2 years. For decades, we used Russian tractors and implements, but today we work with those produced in Western Europe and Hungary. Our germination testing laboratory has been upgraded by purchasing new incubators. The analytical, genetic and tissue culture laboratory has been equipped with state-of-the-art devices (Figure 5). In the future, we plan to renovate the greenhouses built in 1961 and also to obtain phenotyping systems.

Breeding and maintenance of varieties

Since its establishment, NBGK has regarded plant breeding as an important secondary activity. Our institute used to be one of the sites of the national variety testing network, where the performance testing of candidate varieties (plant materials under a 3-year registration process) took place. By applying the methods of positive individual selection and crossbreeding, the researchers of the genebank have developed 28 new varieties (Table 5). The qualifying certificates of our listed varieties are kept in our library (Figure 6). Many of them have been on the National List of Varieties for decades. The maintenance and propagule production of these varieties also take place in Tápiószele. Today, three Jerusalem artichoke (*Helianthus tuberosus*) varieties ('Tápiói korai', 'Tápiói sima', 'Tápiói piros') and one sweet potato (*Ipomoea batatas*) variety ('Tápiói 96') are included in this process.

In 2023, our genebank applied for the registration of 17 candidate varieties on the National List of Varieties in the following categories: variety, landrace and variety developed for growing under particular conditions.

Our candidate varieties are: one peanut (*Arachis hypogaea* L.), two chickpea (*Cicer arietinum* L.), two cowpea (*Vigna unguiculata* (L.) Walp.), one teff (*Eragrostis tef*), one coracan (*Eleusine coracana*).

Our landrace candidates are: one sunflower (*Helianthus annuus* L.), one sorghum (*Sorghum bicolor* (L.) Moench.), one millet (*Panicum miliaceum* L.), two flax (*Linum usitatissimum* L.), one barley (*Hordeum vulgare* L.), one maize (*Zea mays* L.), one safflower (*Carthamus tinctorius* L.), one fodder watermelon (*Citrullus amarus* Schrad.), two tomato (*Lycopersicon esculentum* Mill.), one paprika (*Capsicum annuum* L.).

Our candidate variety developed for growing under particular conditions is: one lentil (*Lens culinaris* Medik.).

Our tomato and paprika landrace candidates were selected from genebank collections of 2,097 accessions and 3,615 accessions, respectively. We also perform preparatory and monitoring activities for variety development for other species, such as winter wheat, rye, common bean, kidney vetch (*Anthyllis vulneraria* L.), crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.), timothy grass (*Phleum pratense* L.), smooth brome (*Bromopsis inermis* (Leyss.) Holub), poppy, onion, beetroot (*Beta vulgaris* L. subsp. *vulgaris*), parsley (*Petroselinum crispum* (Mill.) Fuss), carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), calendula (*Calendula officinalis* L.), summer savory (*Satureja hortensis* L.), dill (*Anethum graveolens* L.) and oregano (*Origanum vulgare* L.). In the case of these species, we currently do not have enough seeds for variety certifying analyses and for

Figure 4. Ceremonial handover of the new genebank building of the National Centre for Biodiversity and Gene Conservation (NBGK) on 10 July 2024. We plan to use this new building for at least 50 years for professional conservation of plant genetic resources in Hungary. Photo by Anikó Gál Soltész, NBGK

Figure 5. (a) Oat (*Avena sativa* L.) accessions in the active storage room at a temperature of 5–8°C in 2015; (b) Sowing of spiked cereals with a plot seeder in autumn 2019; (c) Measuring crude protein content in the biochemical laboratory in 2022; (d) DNA isolation from tetraploid wheat accessions in 2022. Photos by Attila Simon, Lajos Horváth and Dóra Bárdos.

Minősítő oklevél

A Mezőgazdasági Minősitő Tanács a Forradalmi Munkás-Paraszt Kormány 41/1961. (XI. 18.) Korm. számu rendeletében meghatározott jogánál fogva az országos fajtakisérletek, illetve a nagyüzemi fajtapróbák, valamint országos termesztési tapasztalatok alapján

Pannonia lo szója

fajtát

államilag elismert

nemesitett fajtának nyilvánitja.

Ez a körülmény a növényfajtaelismerési könyv 542. számu lapján bejegyeztetett.

A 10/1962. (VI. 15.) F. M. számu miniszteri rendelet 6. §-ában foglaltak alapján a végzett nemesitő munka arányában a növényfajta előállitói

Ferenczi Viktor 100%

Jelen bizonylatot a Mezőgazdasági Minősitő Tanács azzal adja ki, hogy az a növényfajtára megadott minősités visszavonásáig érvényes és a növényfajta az emlitett fajtanév és állami minősités szószerinti megjelölésével forgalmazható.

Budapest, 1967 szeptember 21.

elnök

Figure 6. Qualification certificate of the soybean variety called 'Pannonia 10' from 1967. The breeder was Viktor Ferenczi. Digitalized by NBGK Library.

super-elite multiplication, and the different varieties still need to be fully described. We plan to apply for the registration of these candidate varieties on the National List of Varieties within the next five years.

The registration of landraces on the National List of Varieties is difficult in Hungary due to bureaucratic reasons, since these varieties cannot fulfil the criteria of uniformity during the DUS tests (Distinctness, Uniformity and Stability), or they often do not exceed the yield level of modern improved varieties used as control varieties during performance tests.

Hungarian and international scientific and social relations

The institute has always worked to meet international professional requirements (Cromarty *et al*, 1982; FAO, 2014). Director Dr Andor Jánossy organized the EUCARPIA congress in Budapest in 1974 (Jánossy and Lupton, 1974), during which the participants also visited the genebank in Tápiószele, which by that time already had an international reputation (Figure 7). In addition, our institute published the scientific journal Agrobotanika between 1959 and 1975, presenting the results of research colleagues and describing collecting trips.

Hungary signed the Convention on Biological Diversity (CBD), ratified the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and joined the quality assurance programme of A European Genebank Integrated System (AEGIS). Our institute is member of the Promoting a Plant Genetic Resources for Europe (PRO-GRACE) consortium, created within the Horizon Europe programme in 2023. We participate in ECPGR Working Group activities, and our collection is available in the *ex situ* database of the European Search Catalogue for Plant Genetic Resources (EURISCO). NBGK provides the presidency of the Hungarian Plant Genebank Council, a consultative platform established in 2011. It works as an independent professional advisory board besides the Minister of Agriculture. It is responsible for the professional representation of plant gene conservation, as well as related research and development issues in Hungary. Additionally, it provides expert opinions on legislation, applications and national programmes related to plant gene conservation, including to the Minister of Agriculture. We have contacts with several universities and around 30 university students spend their professional practices in the genebank every year, who may become future employees of the institute. We participate in joint research and development projects together with universities and innovative enterprises from the commercial sector. We perform field experiments with drought-resistant alternative species, edible grain legumes, fodder cereals, oil crops and Jerusalem artichoke, winter and spring lentil, chickpea and poppy. We study the chemical composition of apple, pear, apricot, pumpkin, beetroot, celeriac, carrot, tomato and herb accessions stored in the genebank by analytical methods (Table 6). In our genetic laboratory, we analyze tetraploid wheats (Röder *et al*, 1998) and the genetic relationship between *in vitro* conserved potatoes by using SSR (simple sequence repeats or microsatellite) markers.

Table 5. Registered plant varieties in Hungary bred/maintained by the National Centre for Biodiversity and Gene Conservation (NBGK) (1954–2024). Year, year of registration in Hungary.

Denomination of species				
Scientific name	**Common name**	**Hungarian name of variety**	**Breeders**	**Year**
Avena sativa L.	Oat	Tápláni csupasz	Mr Miklós DEUTSCH, Mrs Zsuzsa WESEL	1973
Capsicum annuum L.	Sweet pepper	Kocsolai zöldhúsú	NBGK	1970
Glycine max L.	Soybean	Pannonia 10	Mr Viktor FERENCZI	1967
Glycine max L.	Soybean	Tápláni takarmány	Mr Árpád SZÜCS, Mrs Zsuzsanna KANYÓ	1968
Helianthus tuberosus L.	Jerusalem artichoke	Tápiói korai	Mr Lajos HORVÁTH, Mrs Ágnes BÁRDY, Mr László HOLLY, Mr József BARTA	2003
Helianthus tuberosus L.	Jerusalem artichoke	Tápiói sima	NBGK	2003
Helianthus tuberosus L.	Jerusalem artichoke	Tápiói piros	NBGK	2022
Hordeum vulgare L.	Spring barley	Tápláni tavaszi	Mr Miklós DEUTSCH, Mr Andor JÁNOSSY Dr, Mrs Józsefné NÉMETH	1968
Ipomoea batatas L.	Sweet potato	Tápiói 96	NBGK	2003
Lycopersicon esculentum Mill.	Tomato	Tápláni konzerv	Mr János ÁVÁR, Mrs Jánosné ÁVÁR	1970
Medicago sativa L.	Alfalfa	Bánkúti	Mr Andor JÁNOSSY Dr, Mr Zoltán CSÁK, Mr Zoltán BÖJTÖS	1961
Medicago sativa L.	Alfalfa	Békésszentandrási	Mr Andor JÁNOSSY Dr, Mr Zoltán CSÁK, Mr Zoltán BÖJTÖS	1961
Medicago sativa L.	Alfalfa	Nagyszénási	Mr Andor JÁNOSSY Dr, Mr Zoltán CSÁK, Mr Zoltán BÖJTÖS	1961
Medicago sativa L.	Alfalfa	Szarvasi	Mr Andor JÁNOSSY Dr, Mr Zoltán CSÁK, Mr Zoltán BÖJTÖS	1961
Medicago sativa L.	Alfalfa	Tápiószelei 1	Mr Andor JÁNOSSY Dr, Mr Árpád SZÜCS	1970
Melilotus albus Medik.	Sweet clover	Kecskeméti kétéves	NBGK	1969
Oryza sativa L.	Rice	Nucleoryza	Mr Zoltán SAJÓ, Mr József SIMON	1979
Panicum miliaceum L.	Millet	Topáz	NBGK	1986
Phaseolus vulgaris L.	Bean	Nagykállói étkezési	Mr Ambrus SZABÓ, Mrs Ambrusné SZABÓ	1979
Phaseolus vulgaris L.	Bean	Tápiói cirmos étkezési	Mr Árpád SZÜCS, Mrs Árpádné SZÜCS, Mrs Józsefné NÉMETH	1980
Phaseolus vulgaris L. var. *nanus*	Bean	Tápiószelei barnabab	Mr Árpád SZÜCS, Mrs Zsuzsanna KANYÓ	1967

Continued on next page

Table 5 continued

Denomination of species				
Scientific name	**Common name**	**Hungarian name of variety**	**Breeders**	**Year**
Phaseolus vulgaris L. var. *nanus*	Bean	Tápiószelei fürjbab	Mr Árpád SZÜCS, Mrs Zsuzsanna KANYÓ	1967
Phaseolus vulgaris L. var. *nanus*	Bean	Tápiói gyöngybab	Mr Árpád SZÜCS, Mrs Zsuzsanna KANYÓ	1970
Trifolium incarnatum L.	Crimson clover	Kemenesaljai	Mr Andor JÁNOSSY Dr, Mr Miklós DEUTSCH	1968
Trifolium pratense L.	Red clover	Táplánszentkereszti diploid	NBGK	1954
Trifolium pratense L.	Red clover	Táplánszentkereszti	Mr Miklós DEUTSCH	1955
Trifolium pratense L.	Red clover	Hungaropoly tetraploid	Mr Andor JÁNOSSY Dr, Mr Miklós DEUTSCH, Mrs Lajosné HORVÁTH Dr, Mr Árpád SZÜCS, Mr László BÁNYAI	1966
Trifolium pratense L.	Red clover	Tápiói tetraploid	Mr Andor JÁNOSSY Dr, Mr Miklós DEUTSCH, Mr Árpád SZÜCS, Mrs Lajosné HORVÁTH Dr, Mr István SULYOK	1970

Additionally, we coordinate our own on-farm network. Within a given landscape and agricultural district, plant populations adapted to local biotic and abiotic factors are often the most stable varieties (Holly *et al*, 2009). The on-farm programme was launched with four farmers in 2018. The network is expanding; in 2024, we are working with 20 farmers. Collecting seeds in their fields or gardens and recording information concerning the motivation of farmers in growing these varieties has contributed to our knowledge of agricultural biodiversity. Landraces of crops such as maize, vetches, cucurbits, beans, paprika, rye (*Secale cereale* M. Bieb.) and some underutilized species (i.e. safflower) are used in on-farm conservation in various regions within Hungary. Farmers and gardeners taking part in the programme can try those landraces which had been collected from their area decades ago. Our partners worked with 430 landraces between 2018 and 2023. Since they report on their experience, the genebank gets useful first-hand information on the actual producibility and marketability of these plant genotypes.

Our results are published in an open-access format (Gyurkó *et al*, 2023; Kis *et al*, 2023). Besides international scientific articles, our Hungarian popular publications are also well-known among the local people. We also organize and take part in seed swaps run by NGOs in different parts of the country. Our institute is open for groups of visitors by prior arrangement. Every year we present the genebank to hundreds of professionals and lay visitors in Tápiószele.

Distribution

The National Gene Conservation Strategy sets measures for the accessibility, mobilization and distribution of genebank samples. Increasing and keeping this activity at a high level has become the most important tool for the utilization of the collections.

Distribution has been one of the goals of our institute since the beginning (Figure 8). In the first ten years of operation, the genebank disseminated about 5,000 seed samples for plant breeding purposes. Between 2019 and 2023, we registered 10,136 seed requests, from which 9,915 have been fulfilled by shipping 92,100 samples.

We operate a separate website for this activity (www.mintakeres.hu), which works as a webshop. There are two seed dissemination campaigns each year (one in spring and the other in autumn). The majority of seed distributions (83.85%) are directed to hobby gardeners and farmers, with the remaining part to NGOs, breeding and research institutes (Table 7). According to the research coordinated by the Centre for Genetic Resources, The Netherlands (CGN) within the PRO-GRACE consortium in December 2023, the situation is the opposite for the majority of European genebanks for which the majority of distributions are directed to breeding and research institutes (van Hintum, unpublished). For scientific, research-related, educational or cultural seed requests, our whole collection is available in addition to those varieties listed in the webshop. However, in this case, a standard material transfer agreement (SMTA) (Correa, 2006) needs to be signed, and the number of stored propagules should not fall below our critical threshold limit as a result of the request (2,000 seeds on average). The most distributed species in the last five years were paprika (10,289 samples), tomato (9,234 samples), maize (4,225 samples), basil (*Ocimum basilicum* L.; 1,916 samples) and common bean (1,865 samples). We shipped 425 samples abroad. About 60% of them were requested by research institutes, while the remaining others by hobby gardeners. The number of seed requests reached its peak in 2023, while the number of distributed samples peaked in 2021. We aim to maintain these same high levels of distributions in the future. This is not a profitable activity for our institute since those requesting seeds only have to pay a 5 EUR handling fee. Seed dissemination for research and educational purposes is free of charge.

The fruit gardener agreement – 'Agreement on cooperation in the conservation of fruit varieties long cultivated in the Carpathian Basin and adapted to local circumstances' – coordinated by NBGK is connected to our fruit varieties collection. This initiative aims at the reintroduction of old fruit varieties, landraces and local varieties to municipal sites, church gardens and schoolyards. Fruit saplings are provided free to the applicants by NBGK. So far a total of 329 gardens have been established throughout the country using 13,728 fruit tree scions. Children are also involved in the process of planting trees, and in this way, the next generations will be more engaged in the conservation of genetic resources (Figure 9).

Future plans

Our new seed cold storage facilities, opened in 2024, provides the basis for further expansion of our collection. We aim to make full use of this infrastructure and store at least 70,000 accessions within the next few years. We will increase the current number of employees from 130 to 150. We plan to invest in a new building dedicated to *in vitro* conservation activities and in a new greenhouse suitable for performing research activities and plant physiology analyses. We intend to decrease the average age of our machines, especially tractors, and to obtain new equipment for our laboratory, including a capillary electrophoresis instrument and a huller for glumaceous cereals. These would actively contribute to increasing the number and quality of our scientific publications. We will apply for the registration of many new candidate varieties on the National List of Varieties in the next few years. We would like to further develop our database and elaborate a quality assurance system that is consistent with other European genebanks.

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Figure 7. Participants of the international EUCARPIA conference study hemp (*Cannabis sativa* L.) plots in the nursery of the genebank in Tápiószele in June 1974. Photo: NBGK Archives.

Table 6. An example of biochemical diversity – sugar, crude protein and crude fibre content – of some celeriac varieties maintained in Tápiószele from the harvest of 2022 (all data is the average of three replications, and they refer to dry matter).

Name of variety	Fructose (g/l)	Glucose (g/l)	Sucrose (g/l)	Fructose + glucose + sucrose (g/l)	Crude protein (%)	Crude fibre (%)
Albin	0.172	28.175	17.369	45.716	11.78	7.76
Apia	0.138	33.404	27.683	61.225	11.42	8.18
Balder	0.131	34.826	22.008	56.964	14.23	7.40
Brilliant	0.332	30.419	20.702	51.453	10.10	8.80
Bükkzsérci	0.289	30.334	19.081	49.704	13.29	8.98
Erdőhorváti	0.634	30.494	18.268	49.396	11.58	8.56
Frigga	0.052	33.547	28.188	61.788	9.56	8.87
Hegykői	0.130	32.694	25.698	58.523	12.63	7.39
Imperator	0.252	34.446	23.667	58.365	13.26	8.46
Kecskeméti	0.133	31.141	22.745	54.018	11.02	7.99
Kéki	0.219	32.215	17.727	50.161	10.76	7.82
Kisteleki	0.129	36.822	20.417	57.367	11.23	8.04
Maxim	0.027	30.111	27.605	57.744	11.93	8.23
Neon	0.042	29.174	22.858	52.074	10.79	8.14
Nyíregyházi	0.925	37.688	20.200	58.813	11.72	8.15
Prágai óriás	0.157	29.142	16.604	45.903	11.04	8.49
Sótonyi	0.236	33.636	25.449	59.320	9.97	8.90
Taktaharkányi	0.313	43.278	23.438	67.029	13.19	9.27
Tarpai	0.644	32.368	18.054	51.067	12.09	8.94
Trizsi	0.123	31.512	20.378	52.013	12.60	7.72

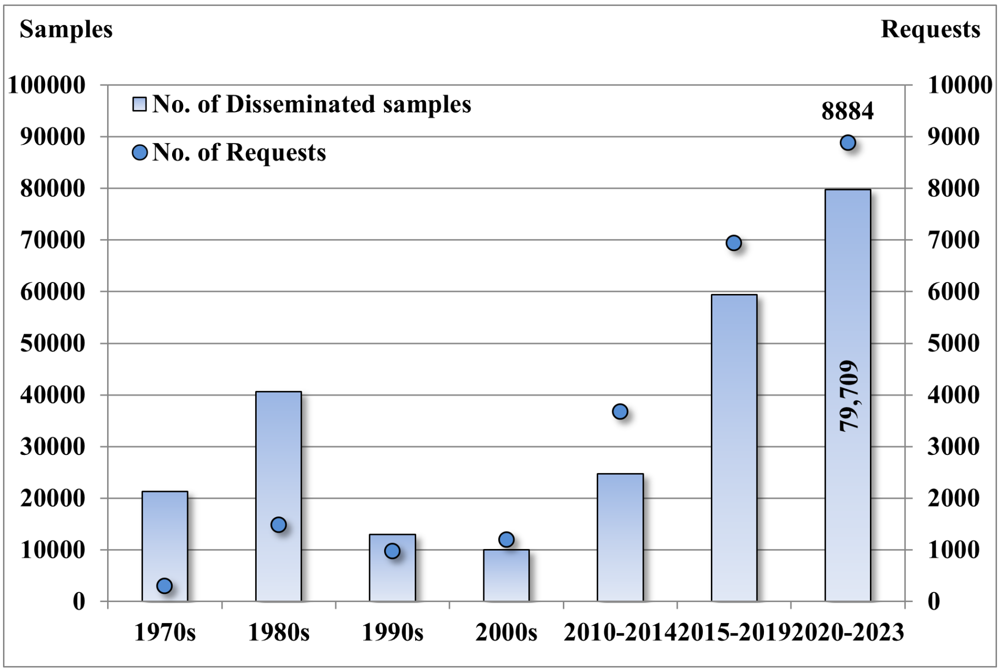

Figure 8. Propagules disseminated from the National Centre for Biodiversity and Gene Conservation (NBGK) between 1973 and 2023. End of data collection: 31 December 2023.

Table 7. Number of propagule requests and distributed samples by type of requesters between 2019 and 2023.

		Hobby gardeners	Farmers	Research institutes Public	Research institutes Private	Educational institutes	NGOs	Museums	Munici-palities	Total
2019	Requests	1,157	17	15	4	5	5	2	0	1,205
	Samples	9,474	58	148	41	31	2,638	1	0	12,391
2020	Requests	1,376	21	3	2	6	3	0	0	1,411
	Samples	10,919	99	39	16	191	2,945	0	0	14,209
2021	Requests	2,394	24	2	4	4	1	4	1	2,434
	Samples	19,150	259	3	53	58	2,500	42	3	22,068
2022	Requests	2,287	30	3	5	9	4	2	0	2,340
	Samples	16,615	134	34	276	321	3,964	25	0	21,369
2023	Requests	2,481	29	8	1	2	1	1	2	2,525
	Samples	20,027	487	133	1	58	1,250	2	105	22,063
Total	Requests	9,695	121	31	16	26	14	9	3	9,915
	Samples	76,185	1,037	357	387	659	13,297	70	108	92,100

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Declaration

The authors declare that the photos do not infringe on any personal or property rights, and that all people shown in the pictures have given their consent for publication.

Author contributions

Zoltán Áy edited and wrote the paper. Attila Simon conceived, designed and performed the analysis. Adrienn Gyurkó collected the data on fruit crops. Evelin Fekete collected the data on horticultural crops. Balázs Horváth collected the data on arable crops. Borbála Baktay collected data on the history of the institute.

Conflict of interest statement

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speaker's bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript. This statement indicates that the above information is true and correct.

Figure 9. Even the youngest ones can be engaged in gene conservation. Planting of landrace fruit saplings provided by the National Centre for Biodiversity and Gene Conservation (NBGK) in Sokorópátka (Northwest Hungary, December 2021). Photo by Balázs Csapó, www.kisalfold.hu

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